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THE GOLD MINES OF THE WITWATERSRAND, SOUTH AFRICA.

By John Hays Hammond.

I.—THEIR RAPID DEVELOPMENT, AND THE GEOLOGY OF THE REGION.

IN the northern part of the South African Republic (Transvaal) is situated the Witwatersrand mining district, embracing an area of 1,200 square miles.* It is connected by railway with the seaports of Cape Town, Durban, and Delagoa Bay,—1,013, 483, and 377 miles respectively. The Witwatersrand occupies a portion of the high plateaux of South Africa at an elevation of from 4,200 to nearly 6,000 feet above the sea-level. This elevation countervails the debilitating influence of its tropical latitude, imparting to the country a climate of unexcelled salubrity. It is, however, too true that the death-rate of certain parts of the district is abnormally high, that of Johannesburg reaching 59 deaths per 1,000 in the year 1895. But this high mortality is attributable solely to the wretched hygienic conditions that obtain. These conditions are susceptible of betterment by good government, and with improved sanitation, etc., Johannesburg would be a veritable sanatorium.

The physical aspect of the country is strikingly like the western plains of America, somewhat less regular in its undulations perhaps, but almost equally destitute of indigenous trees.

In the vicinity of Johannesburg, the chief emporium of the country, is a ridge of quartzite, with an easterly and westerly trend. This ridge is known as the Witwatersrand, or White Waters Range, and gives the name to the district. It forms the water-shed between

*The term Witwatersrand is locally more limited in application, being the name of one of several districts, which together include all the auriferous banket fields of the Transvaal.

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JOHANNESBURG IN THE EARLY DAYS. FROM A PHOTOGRAPH TAKEN ABOUT TEN YEARS AGO.
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THE SIMMER AND JACK MINES, WITH THE WITWATERSRAND RANGE IN THE BACKGROUND.

the Atlantic and Indian oceans. Twelve years ago it was hardly more than "uninhabitable downs, where geographers placed elephants for want of towns."

Jealous of their hard-earned independence, and apprehensive of the result of the influx of population that would inevitably follow the discovery of gold, the Boer inhabitants had passed laws making it illegal to prospect for gold within the country. Not until 1868, when impelled by the dire financial straits of the government to take measures to replenish the exhausted exchequer, was a different policy adopted; and then a bonus was offered for the discovery of paying gold fields. The success of this expedient is well attested by the in-

COMMISSIONER STREET, JOHANNESBURG.
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crease in revenue from £177,876 in 1885 to £4,886,000 in 1896.

As a result of this incentive, prospecting was actively carried on by the Uitlander class,* and alluvions and quartz veins were discovered in various parts of the Transvaal. It was not until 1885, however, that the gold-bearing conglomerate beds were discovered. At the end of that year a five-stamp battery was erected, and in 1886 the farms in the vicinity of Johannesburg were proclaimed "public diggings." A rush for the new gold fields soon set in. The township of Johannesburg was laid out in the latter part of 1886, and the

*Uitlanders means the outlanders,—those not born in the country.

fabric of a great mining centre began, but under conditions most untoward, owing to the inaccessibility of the nearest railway termini, about 293 and 366 miles distant. The fortunate discovery of coal fields in close proximity to the mines has contributed greatly to the successful development of the industry. This discovery was made almost immediately after that of the banket reefs.

In 1892 the main trunk-line from Cape Town was pushed forward from its then northern terminus to Johannesburg. The distance from Cape Town to Johannesburg by rail is 1,013 miles. In 1894 the road was completed from Delagoa Bay, a port in Portuguese territory

SIMMONDS STREET, IN FRONT OF THE STOCK EXCHANGE, JOHANNESBURG.
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on the south-east coast of Africa, to Johannesburg —a distance of 377 miles. The third road reached Johannesburg a year later, from Durban, a port in the British colony of Natal, distant 483 miles.

From 23,000 ounces of gold in 1887, the annual out-put has risen to 3,000,000 ounces in 1897, giving the Transvaal the second place in the world's gold production. As I shall show later, there is no doubt that the present output of the country will rapidly increase; and probably within a few years, notwithstanding the increased outputs of other countries, the Transvaal will rank first as a gold producer.

The town of Johannesburg may be taken as a good index of the wonderful expansion of the gold-mining industry of the district.

From a few huts in 1886, it has developed into a town unexcelled, if indeed equalled, in the imposing character of its buildings by any of the enterprising mining towns in western America. Indeed, Johannesburg has but little of the aspect of an American mining camp. In its general appearance it reminds an American more of Spokane or Salt Lake City. Its population in 1896 was 70,000 whites and about 250,000 blacks.

The scope of this article admits description of only the salient geological features of the auriferous deposits. The gold occurs in parallel beds of conglomerate interstratified with quartzites, sandstones, and schists of several lithological varieties. While some of these schists are of sedimentary origin, there is no doubt that, as sug-

THE RAND CLUB, JOHANNESBURG.
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gested by Hatch, many are derived by mechanical and mineralogical metamorphism from basic igneous rocks—chiefly from diabases and diorites.*

Hatch, in his recently-issued geological map of the Southern Transvaal †, giving the sequence of the South African strata, correlates the Witwatersrand beds with the "Table Mountain" sandstone occurring in the southern portion of the Cape Colony. The Table Mountain sandstone is in the lower half of what is called the

* For further details respecting the geology, the curious reader is referred to "The Gold Mines of the Rand," by Hatch and Chalmers, published by McMillan & Co., London.
† Published by E. Stanford, Cockspur Street, London.

A GENERAL VIEW OF A PART OF JOHANNESBURG AT THE PRESENT TIME.
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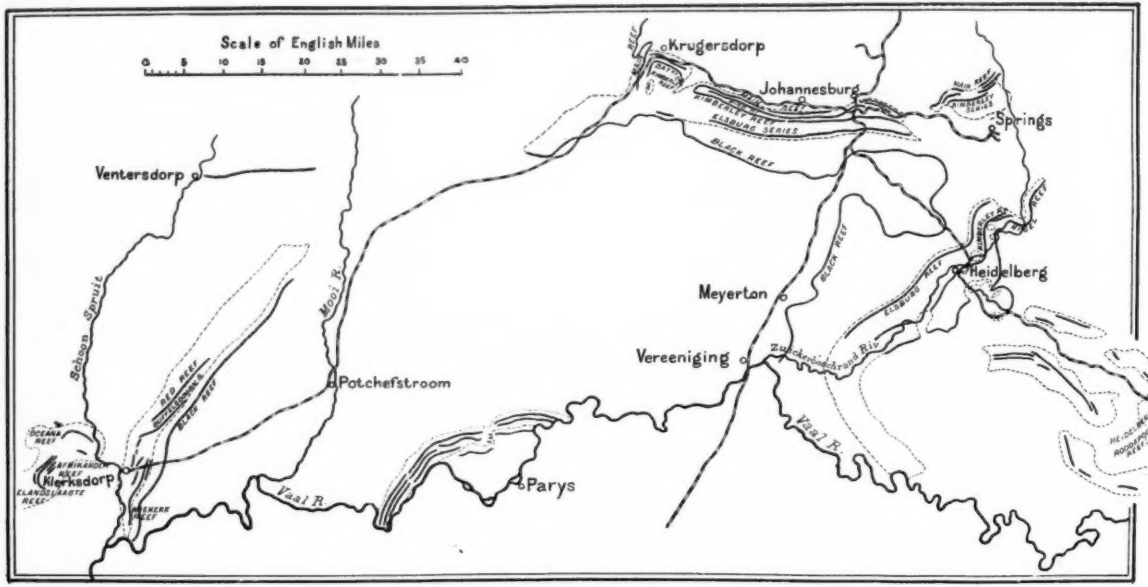


REDUCTION FROM F. H. HATCH'S GEOLOGICAL MAP OF THE TRANSVAAL.

Cape system, which has its probable European equivalent in the Paleozoic.

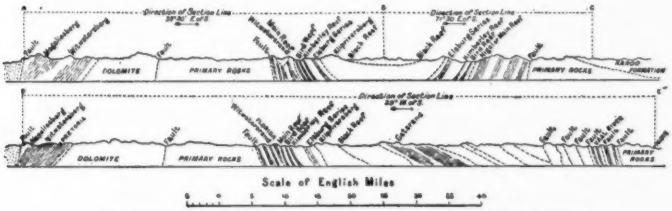
The main sub-divisions of South African stratigraphy, as given by Schenck and Green, are, in descending order:

1. Recent deposits.

2. The Karoo system, to which in its facies the Transvaal coal measures correspond, and which may be assigned to the lower Mesozoic of Europe.

According to Becker, * the coal-bearing beds of the Karoo system are Triassic, or possibly, in part, Permian. They are nearly horizontal, almost undisturbed, and conceal the older rocks over large tracts of country.

3. The Cape formation, the upper division of which includes the dolomite of the Transvaal and the auriferous conglomerate known as the Black Reef; the lower portion,—*i. e.*, Table Mountain Sandstone,—as stated before, includes the Witwatersrand conglomerate beds, and also the banket beds of Zululand and the Orange Free State.



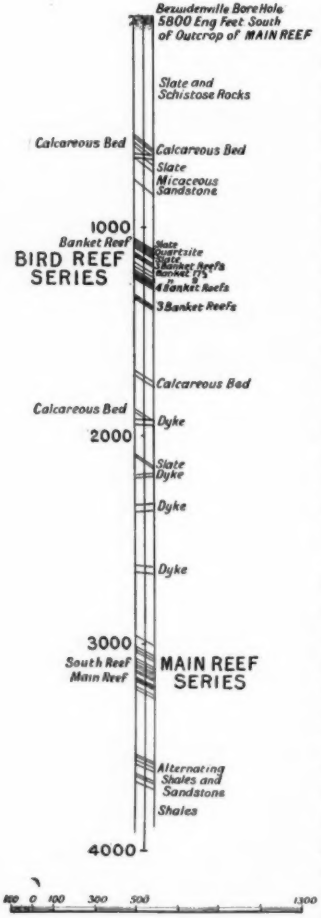
GEOLOGICAL SECTIONS THROUGH THE WITWATERSRAND BEDS.

4. The primary system. This includes the granitic and schistose rocks of many parts of the Transvaal and Rhodesia.

There are several hypotheses as to the origin of the Witwatersrand conglomerate beds, but the only theory which will bear scrutiny is that they are remains of tilted marginal sea deposits. There is not a tittle of evidence in support of the theories of their fluviatal or lacustrine origin; on the contrary, these theories do not square with any of the observed phenomena.

There is no doubt that the conglomerate beds (banket reefs) were originally marginal sea deposits. In the process of the earth's evolution, through causes known to students of dynamical geology,—the approximate cause of which was undoubtedly the intrusion of a large mass of granitic rocks from the north,—the banket-bearing strata were folded into anticlines and synclines. Subsequent erosion has completely removed the anticline. The metamorphism of the arina-

* Published by the United States geological survey. An important contribution.



THE BEZUIDENVILLE BORE HOLE.

ceous shore deposits into highly-indurated sandstones and quartzite accompanied the upheaval. The consensus of expert opinion certainly favours this theory. When it comes, however, to the question of the origin of the gold in the conglomerate, the best of doctors disagree. By those who maintained that the deposits in question are of fluviatal origin it was obviously asserted that the gold was detrital. Unfortunately for the composure of the minds of curious scientists, the fluviatal theory of the origin of the gravels has been found untenable. To-day the point is still controversial, but the scope of theorizing as to the genesis of the gold contents of the gravels is limited to three hypotheses.

The first is the precipitation theory, which has recently been advocated by M. De Launay,* and which is indeed, as Dr. Becker points out, an elaboration of a theory previously suggested by Mr. Penny. This theory maintains that the sea in which the banket was deposited was a saturated solution of gold and pyrite, and that the auriferous contents were deposited *pari passu* with the accumulation of the conglomerate pebbles. A valid objection to this theory is that the gold is confined to the strata of pebbles,—*i. e.*, the banket,—and does not occur in the intercalated sedimentary rocks. As Dr. Becker says, "one would expect to find the sands at least as much mingled with the auriferous precipitate as the banket," and, as he further states, the fundamental hypothesis of a sea highly charged with gold and pyrite seems extremely improbable; otherwise how is the intermit-

* "Les Mines d'Or du Transvaal," published by Baudry & Cie., Paris.

THE DRAKENSBERG MOUNTAINS, ON THE BORDERS OF THE TRANSVAAL.
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A HAMMER BOY IN THE STOPE.

The white pebbles above the Kafir miner's head indicate the banket reef.

tent action of the precipitation of the gold from its menstruum to be explained? Indeed, the fact of the auriferous character of the alternating banket beds and the non-auriferous character of the inter stratified sandstone and schists is, in itself, a refutation of this hypothesis.

The second theory has several able exponents, among whom Dr. Becker is most prominent. He calls it the "marine theory"; as its name implies, it refers the gold contents of the reef to placer origin,

ascribing, however, the presence of crystallized gold to secondary action. There are several important facts which militate against it. According to this theory, the bulk of the gold should occur invariably upon the foot-wall, or lower portions at least, of the reefs. As a matter of fact, the lower are generally richer than the higher portions of the reef, but this is a phenomenon that applies to auriferous quartz veins as well. The larger pebbles generally occur nearer the foot-wall of the reefs, and the gold usually occurs, it is true, with the coarser pebble; but in some mines the hanging-wall portions of the reef, notwithstanding the fact that the pebbles are smaller, contain the bulk of the gold. That the gold is associated with the large pebbles is proved by its absence in many of the bankets which contain larger pebbles than are found in the main-reef series. Indeed, in the main-reef series itself, the south reef, which contains the smaller pebbles, is almost invariably richer than the main-reef leader.

Another important objection to this theory is the occurrence of well-defined pay-shoots in the reefs. Dr. Becker admits the force of this objection, but questions the existence of such shoots of ore, and states that their occurrence would involve the assumption that there are two types of mineralised reefs,—*i. e.*, that the reefs where these ore-shoots are found were mineralised according to the third theory, which he describes as the impregnation theory, to which I shall presently refer.

There are most unquestionable evidences of the existence of such

NATIVE MINERS RETURNING FROM WORK.
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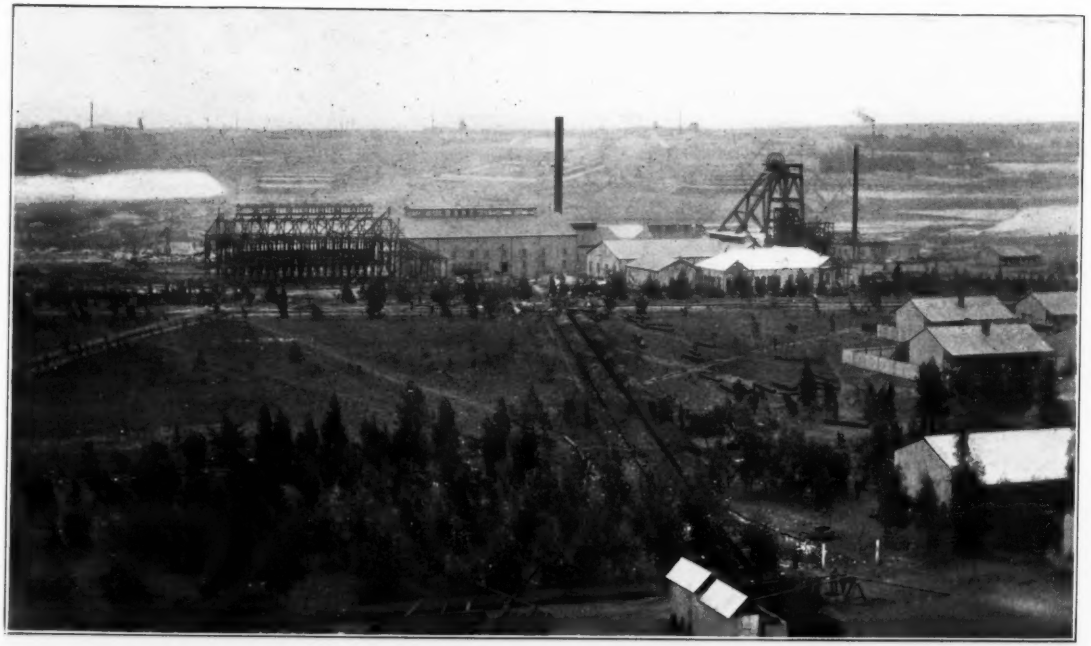
shoots of ore in the Nigel and Rietfontein mines. There are also evidences of shoots in other portions of the Rand, but I agree with Dr. Becker that in the great majority of cases the payable ore occurs in patches rather than in defined shoots. Indeed, it is sometimes difficult to distinguish between a pay-shoot and a mineralised patch. The elongated patches sometimes partake of the shape of ore shoots, but, on the other hand, pay-ore shoots in quartz veins frequently assume shapes identical with those of many of the so-called pay ore patches of the Rand; the line of demarcation is, indeed, at times obscured.

The third theory, suggested by Messrs. Gardner F. Williams and J. S. Curtis, commends itself more favourably to the resident mining engineers of the district. This theory attributes the presence of gold and pyrite in the reefs to deposition from infiltrating solutions, as in the genesis of auriferous quartz veins.

According to this view, the mineralising solutions have come up along the planes of least resistance,—*i. e.*, the interstitial spaces of the banket reefs,—and the gold therefore has been deposited since the upheaval of the conglomerate beds.

Dr. Becker points out some irrelevant objections to this theory. The absence of fissures "in some localities where gold is nevertheless of good grade" is no stronger objection to this theory than to the theory of mineralising of quartz reefs by ascending solutions, where frequently there are long stretches of payable ore without any recognisable connection with the occurrence of such fissures. The gold-bearing solutions come up, as I have stated, along the planes of bedding of the banket, which undoubtedly have had connection with fissures, though generally more deep-seated than those to which Dr Becker refers. Dr. Becker further asserts "that there is no connection whatever between the tenure of the banket and the numerous dykes which traverse the formation." While the statement is generally true that there is as yet no ascertained connection between the richness of the banket and these dykes, there are some most important exceptions to Dr. Becker's assertion.

There are several notable examples of local enrichment of the reefs due to proximity of dykes. A very instructive illustration is in the Worcester mine, where there is an intrusive dyke, lying in the upper levels immediately above the main-reef leader. The hanging-wall portions of the leader, although the pebbles are smaller, are very much richer than the foot-wall portions, and maintain this character until in the lower levels, where the reef, having crossed the banket, forms its foot-wall. From this point the bulk of the gold contents of the reef is found on its footwall.



GENERAL VIEW OF THE ROBINSON DEEP-LEVEL MINE. TO THE NORTH, IN THE BACKGROUND, ARE THE OUTCROP MINES.

In the Ferreira mine there is an interesting occurrence of a dyke containing a considerable amount of visible gold. This dyke lies below the south reef, and is separated from it by several inches of fine quartz. The quartz itself is distinctly auriferous. That the dykes do at times greatly influence the gold tenure and the reefs is conclusively proved at the Buffelsdoorn mine, where indeed the payable portion of the reef is determined entirely by the proximity of the dyke.

The dykes of the Witwatersrand district are of several periods, as evidenced by the character of the faulting which they cause.

Associated with the banket beds, sometimes crossing and faulting

WITCH DOCTORS.

the formation, at other times imbedded with the banket, are numerous quartz veins. The quartz veins usually carry but little gold, but they have in places been found very rich, and have yielded considerable gold when crushed in the battery. As the result of the movement connected with the upheaval of the formation many of the quartz pebbles were cracked, but have been re-cemented by infiltrating quartz solutions. Upon the re-cemented cracks is frequently seen a fine deposit of gold. Sometimes the quartz pebbles have been found encrusted by minute crystals of quartz, which must have been deposited from infiltrating quartz solutions after the upheaval of the beds. The resemblance between the fineness of the gold of the bankets and that in the quartz reefs has in a few instances been proved, though investigations have been too limited to establish a general rule. There is, Dr. Becker to the contrary notwithstanding, a most important amount of visible gold in the unoxidized portions of the reefs.

In view of the foregoing facts, it seems reasonable to conclude, respecting the origin of the gold contents of the reefs, that a considerable portion has undoubtedly been derived from the marine theory, advocated by Dr. Becker. This is what one would expect, as the result of the concentration by natural processes of the eroded croppings of auriferous quartz reefs, as evidenced in the quartz pebbles of the banket bed; but there is undoubtedly present a large amount of crystallised gold that can be best explained by the impregnation theory.

The bankets occupy the outcropping beds of a syncline; erosion has obliterated the anticline, the limb of which was probably in the vicinity of the Magaliesburg Range, shown in the sectional drawings on page 741. In appearance, the outcropping banket reefs form roughly the rim of a basin, though there are many detached parts in the synclinal ore-deposits due to faulting, as well as more or less sinuosity in the lines of the outcropping reefs, owing to superficial inequalities whereby the symmetry of the basin-shape of the deposit is considerably marred; for convenience of description, the term "basin" is applicable. The basin has approximately a width of about thirty miles. There are faulted portions lying at even more than thirty miles from the northern rim. The length of its longer axis is about one hundred miles. Conformably with the shape of the basin, the reefs dip towards a common centre; that is, along the northern edge the reefs dip southward, while upon the southern edge they have a reverse dip, and the reefs upon the western edge and those upon the eastern edges of the basin dip east and west respectively.

In their upper horizons the reefs assume a high angle, frequently more than fifty degrees from the horizon, as the result of tilting, but, when followed in depth, they show a tendency to flatten; probably, at a vertical depth of 2,000 feet below the surface, the angle is rarely more than thirty degrees.

There are several parallel series of reefs within the syncline, at varying distances from one another, but exploitation has been chiefly confined to what is called the main reef series. This series occupies the outer, and therefore stratigraphically the lowest, rim of the basin, though what is known as the Rietfontein reefs, occurring to the east and to the west of Johannesburg, seems to be a still lower series. In the vicinity of Johannesburg this series seems to be wanting. There has been no extensive work upon this reef, with the exception of one mine.

There has been, however, considerable remunerative mining upon another banket series, locally known as the "Black Reef" series. This series lies unconformably above the main-reef series, and, as previously stated, belongs to the upper Cape system. The main-reef series comprises several beds, which have been fairly well correlated along the most developed portions of the Rand,—*i.e.*, to the east and west of Johannesburg, a distance of probably forty miles. No definite nomenclature attaches to these reefs throughout this distance, and it is doubtful if all the bankets are continuously persistent, though analogous reefs occur. Along the central section of the Rand, in the vicinity of Johannesburg, the reefs of the main-reef series in their ascending order are the main reef, the main reef leader, and the south reef. The main reef is by far the largest of the series, frequently as much as fifteen feet in thickness, but it is of low grade, and generally not capable of profitable working under present economic conditions. Immediately overlying the main reef, at distances varying from a few inches to several feet, is the main-reef leader, varying from a few inches to two feet in width. Separated from the main-reef leader by from thirty to two hundred feet of quartzite is the south reef, of about the same width as that of the leader. These two reefs in the portion of the Rand under description constitute the workable ore bodies, and are in value from a few pennyweights up to many ounces per ton.

The banket derives its name from its resemblance to the Dutch confection "banket" (almond rock). It consists almost exclusively of grounded or elipsoidal quartz pebbles, varying in size from that of small marbles to that of hens' eggs. Much larger and much smaller pebbles likewise occur. The cementing material is chiefly siliceous, the silica probably being derived from solutions similar to, if not indeed identical with, the infiltrating solutions by which the mineral-

isation of the bankets is supposed by many engineers to have been effected. The cementing material is also formed in part of pyrite, which is converted by oxidation to the sesqui-oxide of iron, imparting the well-known reddish and brownish colour to the reefs in the upper horizons. The gold occurs free, and also in the auriferous pyrite, which is almost exclusively iron pyrite. Most of the gold occurs in finely-divided crystallized form, usually invisible to the naked eye, though what is known as "visible gold," or "nuggets" analogous to the specimen rock known to our American quartz miners, is also frequently found. Under the microscope some of the gold contents is shown by its water-worn edges to be of detrital origin.

In a subsequent paper I shall discuss the probable gold contents of the reefs, the approximate life of the district, the mining laws under which operations are carried on, and other general considerations which seem worthy of discussion at this time.

These articles will serve as introductory to a series of articles by Messrs. Webb, Yeatman, and Holms, on the mining, milling, and cyanid practice of the Witwatersrand district.*

* These gentlemen are prominent members of the engineering staff of the Consolidated Gold Fields of South Africa, of which company Mr. John Hays Hammond is consulting engineer.—EDITOR.

THE POSSIBILITIES AND LIMITATIONS OF ELECTRIC TRACTION.

By Frank J. Sprague.

II. THE MULTIPLE-UNIT SYSTEM APPLIED TO TRUNK RAILWAY OPERATION.

THE first division of this paper, which appeared in THE ENGINEERING MAGAZINE for January, discussed chiefly the application of the system of individual car equipment to rapid-transit or suburban service. It remains to consider the extension of the same principle to the service of the main line.

Taking up now this larger problem,—not larger in the matter of power or engineering accomplishment, but rather in that of extent,—its discussion has generally recognized but two electrical facts, namely, that a motor, and consequently a locomotive, could be built of suitable size, power, and reliability, and that sufficient energy could be transmitted to operate it; and there has been too often the assumption that centralization means an immense saving in cost of motive power, and that the existence of a water power means supply *ad libitum*, free of cost. Capacity of motors and cost of power have generally been the only problems considered.

New elements have now entered into the discussion. One is the accomplished fact that any number of motors, or electric locomotives, may be intelligently and reliably operated from any selected point on a train. But there are other and serious matters to consider, and these may be briefly stated as the operation of effective signal and automatic braking systems, and power storage or equalization.

While many systems of signalling have been proposed,—some by the writer and many by others,—careful tests must be made in order to warrant implicit reliance on them. The most promising method seems to be the use of devices introduced into the connecting arms from a main to a sectional working conductor. It is not, however, my purpose to discuss these systems here, but it is safe to assume that practical systems can be devised, although the selection is a much simpler matter when considering a new line than when the change or abandonment of existing equipments is involved.

Of electrically-operated brakes, while there are some which are amply powerful, and while motors are themselves available for this purpose, either by returning current to the line in slowing down, or by closing of circuits through resistances, or, in addition, through magnetic brake coils, none are finalities, and the only existing

electrically-operated automatic brake system is that in which a motor supplies air to an automatic air brake. This, for the fullest development of electric traction, is not entirely free from objection, and, if electricity be used to propel, light, and heat a train, it is logical to expect that it will also be used to stop it, and just as effectively. Hence I venture to prophesy (and that prophecy outlines something of my own plans) the not distant advent of an electro-mechanical, automatic brake; and it may be pointed out that on some of the hardest of electric service—that of elevators—various combinations of electric and mechanical brakes are already used.

We are now finally confronted by the condition of supply and its source. Railway service, street and suburban particularly, is analogous to elevator service. It is marked by frequent starts and stops, sharp variations, and quick accelerations and retardations. The load on a generating equipment is varied and severe. This has recently led me to endorse the use of a suitable storage battery under definite restrictions for isolated plants supplying lights and elevators, and to recommend its use in central-station practice, particularly in distributed centres. The result is apparently most encouraging.

It is unfortunate that for many years the progress of the storage battery was practically stopped by vexatious litigation, and by an entire misconception of one of its highest fields of usefulness, which is, in general, service as a regulator or for short-period heavy discharge, rather than for long-time storage and slow discharge. This field of the battery is now more clearly seen, and, for the purpose of these remarks, batteries may divided into storage and regulating types, the latter being constructed with special reference to quick charge and very rapid discharge, with reasonable storage capacity. The improvements made recently have greatly improved the battery, increased its storage capacity, and immensely increased its safe discharge rate. These results, which will be undoubtedly bettered, and with reduced cost, will have a far greater influence on the application of electricity to heavy traction than all the water power in the world for many years, and until the cost of fuel is radically increased. In fact, except in cases where water power is easily available, and cost of fuel prohibitory, the function of water-supply is limited.

In this connection it is interesting to note that in Buffalo, where coal is a dollar per ton, the experience of the Buffalo Street Railway Company has not been favorable to the direct use of water power, though Niagara is but twenty-four miles away. At the current rates, and under the conditions of operation, coal proved the cheaper, and water will make a favorable showing only when the variations are taken care of by a storage battery so that the cost charge, which is made

on the basis of maximum power supplied, may represent more actual energy delivered in twenty-four hours. I think it likely that the application of a storage battery to the steam equipment would show very favorable results. Having come to somewhat similar conclusions about the storage battery, I some months ago made a definite proposal to put on the Manhattan Road of New York a number of individualized cars with the multiple-unit control system, and for the supply through a live third rail I planned to use storage batteries placed at two or more stations, supplied by rotary converters operated from a multiple-phase transmission plant or by one or more steam engines and dynamos of moderate capacity locally situated.

Referring again for a moment to the subject of suburban service, radical as the proposal for the Illinois Central seems, I have no hesitation in endorsing them, as entirely within the range of practical accomplishment.

Given then effective motors, single and multiple control, accepted systems of signalling and automatic braking, efficient transmission and storage regulation of power from whatever source, how far is a trunk line warranted in adopting electricity? Just here it is well to point out some of the conditions which govern trunk-line operation, and the fact that all trunk lines are not alike.

The conditions of passenger traffic on such lines—that is, where long journeys are made—are absolutely different from those on suburban or other short lines, where railway travel is but an incident of daily life, and where the arrival and departure of trains at certain hours, and frequency of units, are absolutely essential to meet the requirements of the suburban resident. If one wishes to go from New York to Chicago, or from London to Edinburg, it matters little that train departures are at two- or three-hour intervals, because the journey is a thing which may be considered by itself. In these days of luxury, it would practically be impossible to concentrate in one or two cars all the advantages which a limited train to-day presents, and no possible traffic which can be safely predicted (especially in view of the fact that between important points competing lines exist) warrants more than a certain number of cars per day in transit. For long-distance travel, then, the present effort of trunk-line managers is concentrated in a comparatively few well-equipped trains, affording all the comforts that a passenger can ask for.

And it is well understood that in freight-handling the constant effort of every progressive railway management is toward concentration of loads by increasing the capacity of cars, the size of locomotives, and the length of trains, and the further equipment of such trains with brakes permitting of their being handled in large units at high speed.

Again, on a large number of trunk roads, passenger service and freight service are performed on the same tracks, rarely on more than two (there being one notable exception in the United States), and very often on a single track, as, for example, the larger portion of the distance between Chicago and New Orleans. So long as tracks do this double duty of freight and passenger service, it is absolutely necessary to concentrate both passenger and freight trains into large units, and to run them at comparatively infrequent intervals. It is safe to say that efficient railway management in the handling of passenger and freight trains, the latter often representing the larger business, on many existing roads will accomplish more in earning a dividend than any saving which can possibly be effected by the introduction of electricity, no matter what the original source of power.

Much has been said and written upon long-distance, high-speed electric railways; but a line could not be built, say from New York to Chicago, devoted exclusively to passenger service, with existing possibilities of passenger traffic, and return an interest on the investment—no matter what the rate of speed determined upon, nor how attractive it could be made.

At all times, as an offset to any saving in transportation account and cost of power, there must be considered the increased investment. While fewer electric locomotives could safely do the work of a given number of steam locomotives, still, considering all classes of equipment, it may be safely assumed that the cost of the power equipment supplied to the rolling stock will be fully as much for any electric system as for steam. It follows that every dollar spent in central stations, whether for water-power or steam engines, turbines, dynamos, or converters, and whatever the system of distribution, is an excess charge against the electric railway, and is warranted only when the saving in fuel, in transportation wages, and in depreciation, or the increase of business, will insure a material dividend on the increase of investment.

Of course, all roads have a very large amount of what may be called *dead* investment, represented in road-bed, tracks, signal systems, etc., as distinguished from rolling stock, which may be called a *live* investment, and which forms so important a part of the total that no one would think, for example, of building a road to be operated ever so cheaply so far as locomotive power and cost of rolling stock were concerned, if a two-train-per-week schedule were to be adopted, such as that of the Sunset Limited from Chicago to San Francisco.

The distributing section of any electric system may be classed as "dead investment," and must necessarily be large, but it is safe to say that even that necessary to convert an active steam line (such as

the New York division of the Pennsylvania Railroad), into an electric system, would be far more profitable, and more certain of earning a good dividend, than that which would be required for constructing a competing steam road running through the same territory.

Increase of traffic requirements, and the spur of competition, are continually making necessary improvements of a character favorable to change of motive power.

Rock ballast, duplication of trackage, abolition of grade-crossings, and practical insurance of private right of way, with the making of intrusion a penal offence, will go far to insure electric traction. All these improvements, however, being the result of increased traffic demands, indicate that the laws which tend to perfection of present equipment also lead to the gradual adoption of electricity.

Without going into any special argument, it may be pointed out that electric motors may be used to assist trains over heavy grades even on a steam section, and that many electric feeders to steam lines will be built, especially where engineering difficulties are pronounced.

Much general prediction has been indulged in on this subject of steam main lines and electric feeders, but, considering the variation in density of traffic on different sections of a trunk-line system, I expect to see in some instances the reversal of this idea, so that the outlying and infrequently-served portions of a system may be steam, while the main section, where train movements are concentrated, may be electric, such sections corresponding to what is now covered by an "engine run."

I may then briefly sum up conclusions:

Motors or motor combinations can be built which will surpass in power, and in tractive and speed capacities, any locomotive which it is practicable to construct and operate.

All necessary power can be efficiently and effectively transmitted for reasonable distances electrically.

Frequency of service is ordinarily a *sine qua non* in determining the adoption of an electric system. Whatever the size of units, if the number between terminal stations be sufficiently large, electricity can be used; if the number be few and infrequent, electricity should not be used.

All street, elevated, and underground railroads and suburban systems, many branch steam lines, special lines built to meet particular conditions, and lines where steam power can be gotten only at high cost, but where water is available within reasonable distance, should now be operated electrically.

The multiple-unit control—that is, the individualizing of cars, and the control of them from any selected point—is the preferable method

of equipment, on any of the above classes of road, whenever train-combinations are at any time advisable.

Locomotives and locomotive cars should be built with multiple motors, power-controlled, and individualized. They should be arranged so that two or more can be operated at will, or automatically, from either end, and from any situation in a train.

Automatic electric brakes, having the general functions of automatic air brakes, will be used on electric systems and also on many steam trains.

The storage battery, so modified as to have a fairly quick charge rate and a very rapid discharge rate, with moderate storage capacity, will come into use as an equalizer, and is of far more importance than existing water powers in determining for the present, and so long as fuel is available at low rates, the application of electricity on a railroad.

The presence of water power "within a few hundred miles more or less" is not of itself sufficient to justify a trunk line in adopting electricity, for, contrary to the usual assumption that water power costs nothing, the interest on the additional investment, and the capitalized risks of possible delays or interruption, will often more than offset the entire cost of coal.

So long as the service of an existing first class steam road is well supplied by a locomotive system with comparatively long trains and infrequent service, and so long as there are but few units between terminal points the road is not justified in adopting electricity.

Electric motors will often be used on special feeders to steam lines, and as boosters on heavy grades. With regard to main-line traffic, on such trunk-line systems as may gradually adopt electricity in part, it will be used on such portions corresponding to an "engine run," as the density of traffic will justify, and it will be preceded by such other improvements in road-bed, abolition of grade-crossings, etc., as are necessary and as would be adopted even if steam were retained.

Finally, every road must be considered by itself in connection with the conditions surrounding its operation, and the business to be developed, and with regard to the probable economies to be effected by a change in motive power as well as by a change in the system of handling trains.

THE ECONOMY AND EFFICIENCY OF THE LARGE GAS ENGINE.

By Dugald Clerk.

IN a former article I reviewed the earlier experiments in the design of the gas engine, and traced the development of types up to the largest units of the present day. It remains to consider the leading difficulties in the problems which now present themselves, and the prospect for their early solution.

There are two classes of difficulties which have hitherto prevented a more extended use of large gas engines. The first class consists of gas-engine difficulties *per se*, and the second of gas-producer difficulties. In all compression-explosion gas engines a charge of gas and air is compressed in a cylinder, and then ignited, and the piston moves out under the pressure produced. The exhaust valve is then opened, and the return stroke discharges the exhaust gases. The piston, however, does not enter the compression space, and in many gas engines a certain proportion of burned gases is thus left in it. This does not seriously affect a small engine, because the cooling surface of the cylinder is so great in relation to the heat evolved by the combustion that, by the time the exhaust stroke is completed, and before a fresh charge of gas and air is admitted to the cylinder, the gases have cooled down to a temperature sufficiently low to avoid ignition of the entering charge. If, however, the engine be of comparatively large dimensions, it often happens that the exhaust gases have not been sufficiently cooled during the exhaust stroke, and consequently these gases retain lingering flame. On the admission stroke of the engine the gas and air admitted to the cylinder come in contact with this flame, and the charge ignites while entering. This, of course, produces an ignition down the admission pipe, and causes the engine to lose an explosion. In the scavenging engines of the Messrs. Crossley a certain volume of cold air is sent through the cylinder to discharge the exhaust-products and fill the cylinder with cold, pure air. This scavenging process has long been advocated by me. I was the first, I believe, to use it in gas engines. This was in 1881. The Otto cycle engine did not adopt any scavenging process until about 1886. Several engines of that type, notably the Griffin engine, adopted a scavenging stroke to clear out the exhaust-products; but adoption of this precaution was not frequent

until about 1894, when the Messrs Crossley introduced Mr. Atkinson's method of scavenging by utilising the velocity of the exhaust in the exhaust pipe, for the purpose of producing a current through the cylinder.

Messrs. Wells Bros. had adopted scavenging in some of their Otto cycle engines before that date, and the engine illustrated last month has a scavenging cylinder taking in an air charge, and discharging it through the exhaust space in each cylinder alternately. The process of scavenging overcomes almost completely this difficulty of lingering flame, and consequent ignition of the entering charge; but, even with the scavenging, unless the engine be very carefully designed to avoid port spaces or any hollows not swept out by the air, the flame is still apt to linger, and to ignite the entering charge. It is not wonderful that this should be the case when one considers that the maximum temperature of the ordinary explosion in a compression-gas-engine cylinder is about 1,800° C., and that in most of these engines the complete revolution is accomplished in one-third of a second,—that is, the forward stroke, after explosion, lasts one-sixth of a second, and the return stroke, discharging the exhaust, lasts another sixth. It is rather remarkable under these circumstances, with so short a time allowed for cooling the explosive mixture, that the flame is burned out so completely as appears to be the case. In small engines it is found that the burning out is very complete. With these, even running at 400 revolutions, it is difficult to ignite on the charging stroke. In large gas engines, however, running at 180 revolutions, the sixth of a second elapsing between the beginning of the exhausting stroke and its termination is not sufficient to so cool down the large volume of the gases as to make the cylinders safe for the admission of another charge. Accordingly, the air charge greatly assists in so preparing the cylinder as to avoid firing while the charge enters.

In modern engines the cylinders and their compression spaces have been so designed as to expose the minimum surface for a given volume, and to expose it as little as possible in the shape of ports, passages, or narrow spaces.

The compression has also been raised in many gas engines to nearly 100 pounds per square inch before ignition. This increase in compression assists very greatly in avoiding back ignitions of the class described, by causing a greater conversion of heat into work during the expanding stroke, and a consequent lower terminal temperature of the gas in the cylinder just previous to the opening of the exhaust valve. In the best of the larger engines, at present, the terminal temperature generally exceeds 1,200° C. High pressure and scavenging

have, however, got rid almost completely of untimely firing on the charging stroke in engines up to and including 200 i. h. p. The higher compression, however, has introduced another difficulty,—that is, a tendency in a large engine for the charge to ignite while on the compression stroke, before the piston has been thrust fully in. That is, a difficulty has been transferred from ignition of the charge as it enters to the premature ignition of the charge during compression. This is due to the considerable rise in temperature of the gases during compression, and to the heat added to those gases from the piston end while compressing. The temperature of the end surface of the piston of a large gas engine, while exposed to frequent explosions, is very considerable. Even with a well-designed piston, it cannot be far short of a low red heat, approaching 700° C. Considering that the temperature of gas compressed to 100 pounds above atmosphere is about 250° C., it is not surprising that occasionally the charge fires during compression by the heat added from the piston. Again, the formation of a very small carbon deposit on the surface of the compression-space would, under these circumstances, also tend to produce ignition during compression. This difficulty is met in the large engine by the use of gas-and-air mixtures not too strong in gas. If too much gas be present, these premature ignitions during compression are very apt to occur, especially in engines where any projecting metal pieces are found in the interior of the cylinder or compression-space It is necessary, in order to avoid this difficulty, to have no bolts or separate projecting pieces from the heads of valves, lest these may heat up and help to produce an ignition apart from the ordinary tube igniter.

These are the leading difficulties with large gas engines so far as the combustion in the cylinder and irregular ignition are concerned. One other difficulty lies in the necessity of providing an ample margin of strength in the engine-frame, crank, connecting rod, and other parts, to stand a pressure considerably higher than the ordinary working pressure. This precaution is necessary because sometimes, from wrong adjustments in the proportions of gas and air admitted, the engine cylinder may be charged with a mixture easily combustible and this may occur after several missed ignitions, so that the cylinder gets completely filled with a mixture which is cold and as rich as possible in gas. Such a mixture may easily produce an explosive pressure thirty per cent. in excess of the usual maximum pressure, and this has to be provided for. In a steam engine no such excess pressures have to be considered.

Then again, the fact of the engine getting only one impulse for every two revolutions necessarily increases the dimensions and weight of the engine. Further, the difficulty of governing gas engines by

varying the impulses, instead of cutting them out, has not yet been overcome. The engines now run very steadily, but not so steadily as do the best steam engines.

In consequence of all these difficulties inherent in the gas engine itself, notwithstanding its great thermo-dynamic advantage over the steam engine, it has not, for large powers, taken the place which it should.

The other class of difficulty is that due to the gas producers now in use. Until very recently, the Dowson gas producer was the only producer practically on the market, and to operate it to best advantage anthracite coal is required, costing about 18 shillings per ton. Notwithstanding, then, that the gas engine consumed about 1 pound of anthracite against 2, or perhaps 2½, pounds of coal in a good steam engine of 200 h. p., the coal bill for the steam engine did not amount to more than the coal bill for the gas engine, because the steam-engine boilers would often use engine slack at about 9 shillings per ton, and sometimes even less. The Dowson producers now employed use coke as well as anthracite, but there are many difficulties with coke which do not yet appear to have been thoroughly thrashed out. The only producer making gas fit for use in the gas engine, and using common engine slack, is the Mond producer, and that, in my opinion, is much too cumbrous to be used to any considerable extent. The Mond producer is excellent where a complete plant is set up for the manufacture of gas and the recovery of ammonia, but it is very expensive, and suitable, so far, only for very large installations.

One great obstacle to its rapid development, apart from the engine itself, undoubtedly lies in the producer, and, until a cheap and easily-operated producer is manufactured, using common engine slack, and producing gas having, say, 80 per cent. of the heating value of the coal used, in a form suitable for a gas engine, it cannot be hoped that very rapid advance will be made.

There is thus ample scope for the engineer on the gas engine. For large powers it is still open to great improvement in itself, and the production of a cheap and economical producer using common coal would lead to an immediate and large extension and increase of competition with the steam engine.

Engineers are now at work overcoming these difficulties, and the line of action is well understood. Compressions are increasing very much, and better results are being obtained with high compressions. Even in small gas engines great advances are still being made in economy of fuel.

The figure on the next page is interesting. It is a diagram from one of the latest of the Crossley engines of 10 h. p. (nominal),

showing a mean pressure of 84.6 pounds, an i. h. p. of 24½, a brake h. p. of 22.2, at 180 revolutions per minute, and a Manchester-gas consumption of 14.32 cubic feet per brake h. p. per hour. To my knowledge, this is the lowest gas consumption yet obtained for a given power, and, when this improvement is applied to the large engine, without doubt it will be possible to get a brake h. p. on 12 cubic feet of gas,—an actual efficiency of more than 30 per cent. of the whole heat given to the engine in the form of gas.

Although I have pointed out the defects of large gas engines, and the difficulties encountered up to the present stage, I have done so, not to discourage, but to assist, engineers.

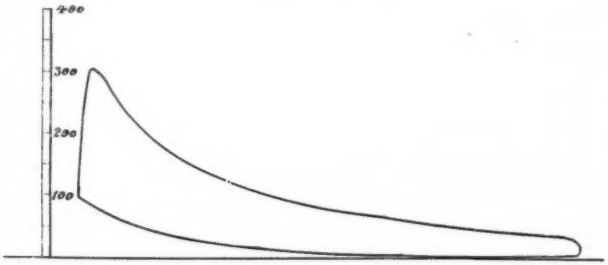

400
300
200
100
Nominal H.P. 10; Rev. per min. 180; Consumption per B.H.P. per hour 14·32 cubic feet of Manchester gas.
Mean pressure 84·6 lbs. Max. pressure 310 lbs.
Initial pressure before ignition 95 lbs. Scale of spring 1/180

DIAGRAM FROM A 10-H.P. (NOMINAL) CROSSLEY ENGINE.

It is evident that the large gas engines of ten years hence will differ as much from the large gas engine of to-day as does the latter from the engine of 1886 or 1887. There can be little doubt that, in ten years, gas engines of 1,000 h. p. will be as common as engines of 100 h. p. are now.

The problem is a most interesting one, both from a commercial and a scientific point of view; but, before gas engines can be applied on ship-board, it will be necessary to greatly improve their construction, governing, and operation. When they are so applied, the great advantage will be that vessels will consume, for the power developed, less than one-half of the fuel at present required. A large gas engine on board a vessel, so far as economy is concerned, could easily be run with half a pound of coal per i. h. p. hour.

SHIP-BUILDING AS A PRODUCTIVE INDUSTRY IN GREAT BRITAIN.

By James McKechnie.

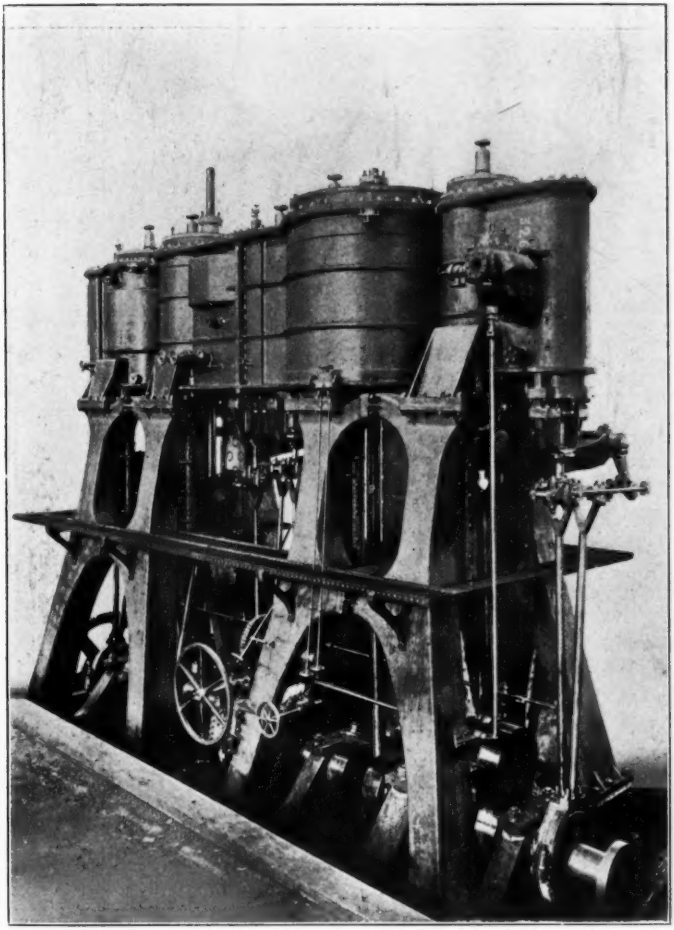
III.—THE DECLINE OF SAIL AND EVOLUTION OF STEAMSHIP TYPES IN THE CHIEF DISTRICTS.

"IT'S only a Geordie." Thus disparagingly do the Clyde people often speak still of the north-east coast ship. It is only natural, for their rivalry increases: but the north-east-coast builders have the satisfaction of knowing that this jealousy is but the reward of some measure of success. Thus, when London was in the front rank,—ere yet the men's exorbitant demands brought ruin,—the pretensions of the Clyde builders were regarded with something of contemptuous fear. But, now as then, there is no reason why all perfection should be confined to any geographical division of Britain, or indeed to any country. There is exactly the same number of firms producing ocean-going steamers on the Clyde as on the north-east coast from Blyth to Whitby. The Clyde firms have produced an average of 345,000 tons during the past seven years, the north east builders 582,000 tons. Both districts are close by the iron and coal field; so also is Barrow; and Belfast and Hull have the advantage of easy railway or steamship communication. Of the other ports, excepting Birkenhead, it may be said that they build only an occasional ship. London depends mostly upon naval or repair work.

The ship-building industry is not so long established on the north-east coast as on the Clyde. This partly accounts for the superiority, or assumed superiority, of their ships of "quality." Sir Charles Palmer, who has long held a prominent position in the industry, built his first iron ship in 1852,—the collier John Bowes, I think,—and for some time the trade was confined to vessels carrying Northumberland coal to the London market. So long as the building of these paid, the firms were not disposed to compete with the Clyde in the production of passenger-steamers which involved speed problems. West-of-Scotland merchants were early associated in commercial pursuits in the United States and across the Spanish main; and this fact, combined with their situation close by the Atlantic, also accounts in some way for their priority in the building of high-speed passenger lines. Thus most of the ships built ten years ago on the Tyne, Tees, and the other rivers in that part of England might almost be said to have been without form or comeliness. The aim was to build a vessel

which would carry the maximum of cargo, coal, or ore; it was the fault of the physical laws, if such a receptacle was necessarily square-ended. Now a fair proportion, although not so great a percentage as on the Clyde, consists of passenger steamers of moderate speed. Still the high-speed steamer is exceptional, if we exclude warships. The Palmer Co., Wigham, Richardson & Co., Swan & Hunter, and one or two others have turned out ships which, for elegance and finish, are, as they themselves are pleased to claim, equal to those of the Clyde. I recall the Alphonso, built by Wigham, Richardson & Co. for Spain, and the Avon, for the Carron Company's service between the Thames and the Forth.

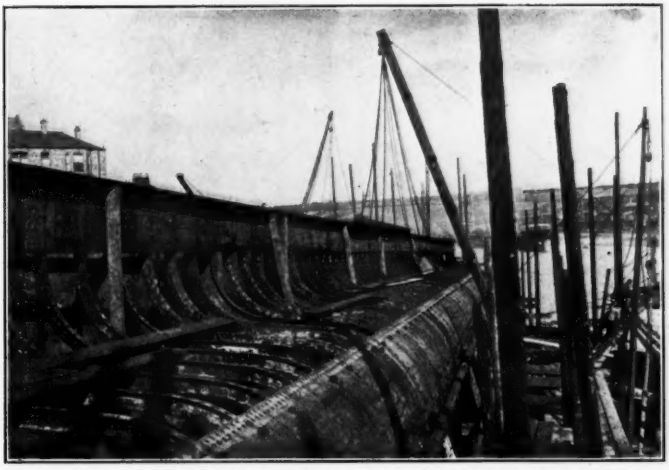
But, after all, an examination of Lloyd's List, which is the most comprehensive in the world, shows that for every twenty vessels built on the west coast—Clyde, Barrow, and Birkenhead—to steam 18½ knots, there is scarcely one north-east-coast ship. The great majority are of the purely tramp type, averaging 3,000 to 3,500 tons. Considerable ingenuity has been exercised in the design to secure the greatest advantage, but I am not going to enter into the mysteries or the controversies associated with all the types; Lloyd's have fourteen classes, and yet fail to satisfy demands. Mention, however, may be made of the Doxford turret type; a small fleet of vessels of that type have been constructed since it was introduced some five years ago. The photograph reproduced on page 766, with the cross-section, renders explanation unnecessary. The form of the weather deck improves the righting moment, but, as I am dealing chiefly with economic considerations, I will say simply that in most cases the hull capacity per net register ton is 25 to 33 per cent. greater than in the spar deck or well-deck steamer of corresponding displacement. The British Association for the Registry of Ships has made this a special class, in view of the great strength of the design: but Lloyd's refuses to do so, and herein perhaps may be discovered some support for the contention that monopoly does not encourage development. A Tees firm—Messrs. Ropner—has also introduced a departure which calls for reference here as an effort towards higher efficiency. It combines the principles of the well-deck, the partial awning deck, and the spar-deck type. There is no 'tween deck, and, instead of the spar-deck extending the full width of the ship, there is a central trunk running fore and aft in continuation of the engine coamings. This trunk is open for its full width to the hold for cargo, the top of it forming the working deck, on which are the winches, while the hatchway is also through it. This type is also illustrated by photograph and section. All firms are making a great effort towards greater fuel economy, and in this respect much has been done for British shipping supremacy.



FOUR-CRANK QUADRUPLE-EXPANSION ENGINES, YARROW, SCHLICK AND TWEEDY SYSTEM.
Constructed by Wigham, Richardson & Co., Newcastle-on-Tyne, builders of the "Avon."

Naturally the reader cognisant of what is being done in this direction will recall the quadruple-expansion engine, of Mr. Walter Brock, of Dumbarton, and Mr. J. Rankine, of Greenock, and Mr. T. Mudd's success with the Inchmona. Mr. D. B. Morison, of Hartlepool, has

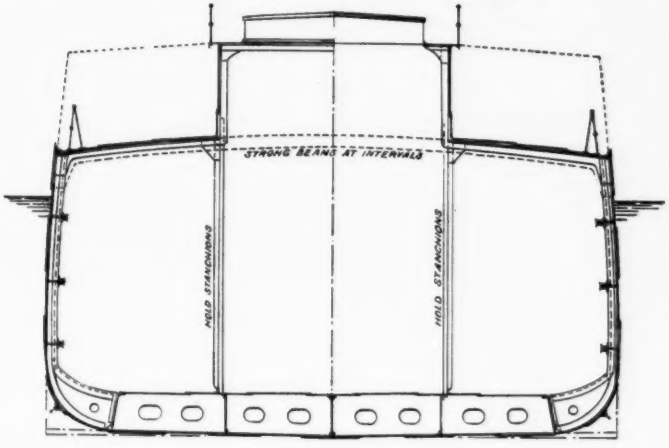
FRAME OF A VESSEL OF THE DOXFORD TURRET TYPE, DURING CONSTRUCTION.
Built by Wm. Doxford & Sons, Ltd., Sunderland.



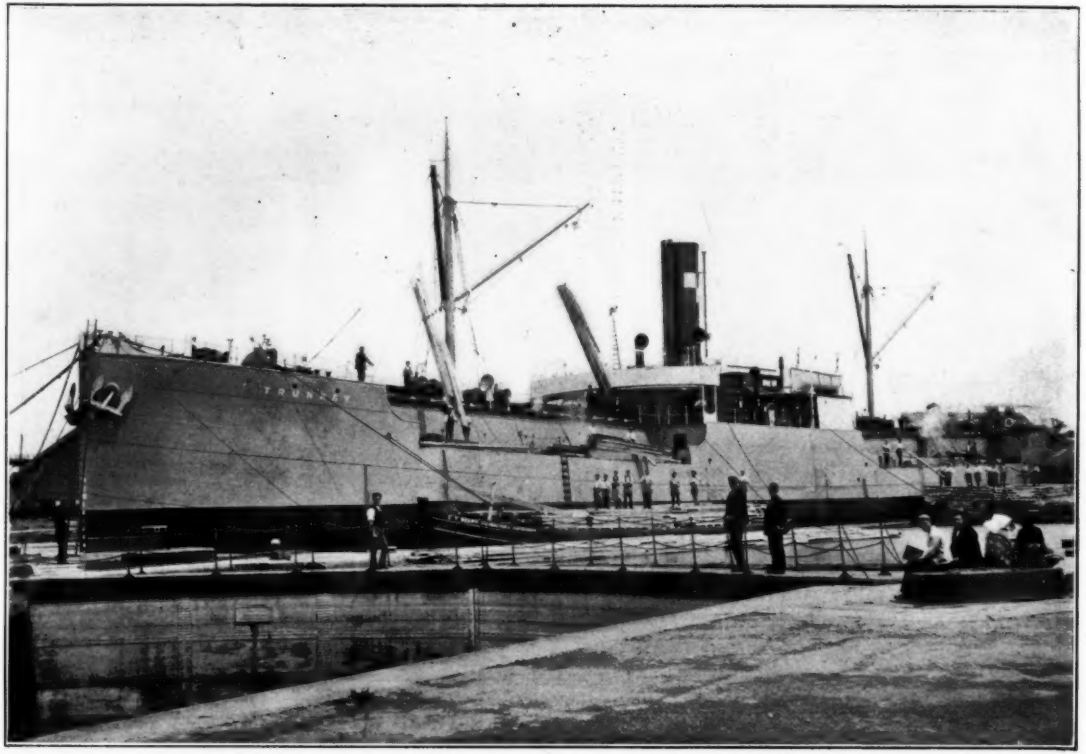
SHIP OF THE DOXFORD TURRET TYPE, IN COURSE OF BUILDING.

also done good service, and Mr. James Howden, of forced-draught fame, need scarcely be mentioned. Apart from engineers proper, Mr. James Weir stands to the front for his pumps and heaters.

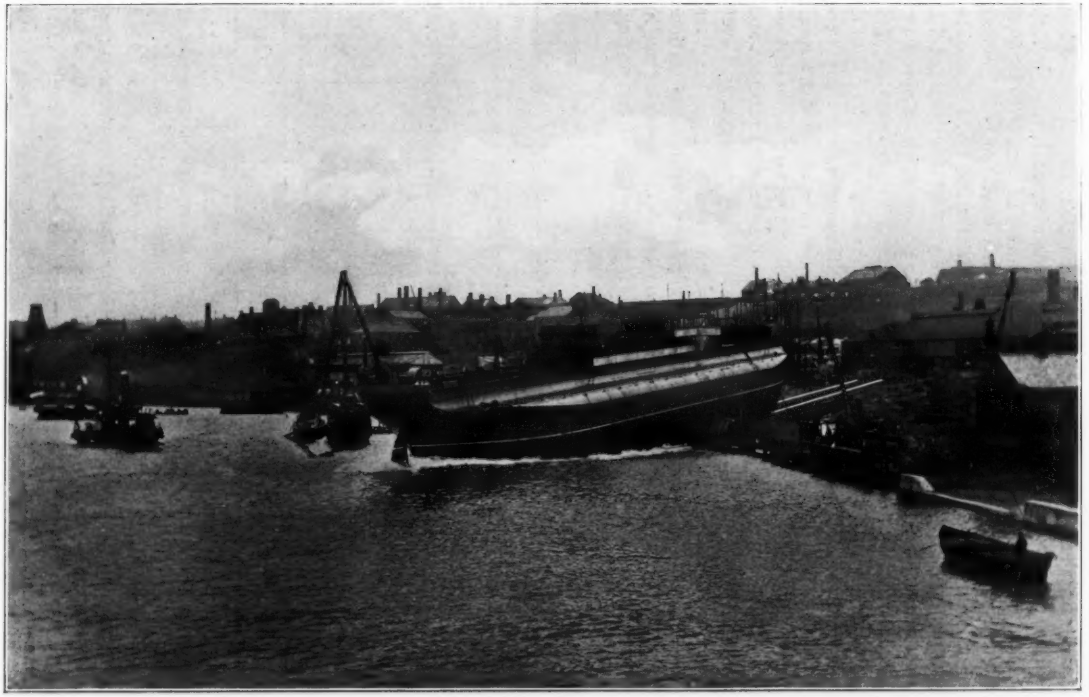
It would be pleasant to dwell on these and other fruitful labours, but I briefly indicate them merely to show that the cargo steamer is



CROSS SECTION OF FIRST SHIP OF THE ROPNER TRUNK TYPE.



ROPNER TRUNK-TYPE STEAMER "TRUNKBY" AT THE WHARF.
Built by Ropner & Son, North Shore Shipbuilding Yard, Stockton-on-Tees.



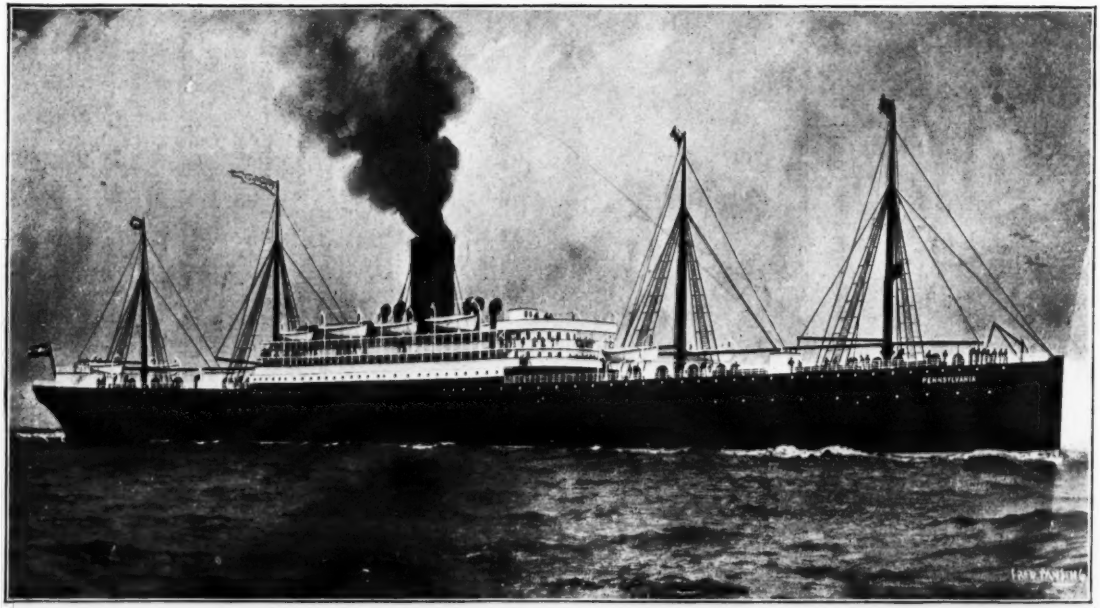
THE LAUNCH OF A TURRET SHIP AT THE PALLION YARD OF MESSRS. WM. DOXFORD & SONS, LTD., SUNDERLAND.

despised by no one. Even on the Clyde quite 80 per cent. of the ships built belong to this category. An examination of Lloyd's List again brings out the extent of their predominance in the world's fleet, the best measure being the small number of vessels capable of exceeding a speed of fifteen knots. In this way, too, one gets an idea of recent progress of such vessels. Britain has now 263, while three years ago she had only 205; in foreign fleets the number has increased from 99 to 133. Britain has 23 vessels whose speed exceeds twenty knots, and of these twelve are paddle-steamers engaged around the channel. Eight of the screw steamers are on the Atlantic, the others being in the channel service. Three years ago there were only ten in all. In foreign fleets the number of steamers with a speed of twenty knots or more is twelve,—only four more than there were three years ago. British vessels whose speed is between nineteen and twenty knots number 23,—an increase of five in three years. Seven of them are in the P. & O. fleet, in which great advance has been made, notwithstanding the long distances between coaling stations and the necessity for depending more on cargo for revenue than in the case of Atlantic liners. The following table may be interesting.

SPEEDS OF SHIPS.

	1894		1897	
	British	Foreign	British	Foreign
Vessels of 20 knots and more.....	10	8	23	12
" 19 -20 knots.....	15	12	23	11
" 18½-19 "	4	3	8	4
" 18 -18½ "	25	4	31	6
" 17½-18 "	9	16	8	14
" 17 -17½ "	29	5	33	15
" 16½-17 "	17	4	16	8
" 16 -16½ "	30	17	33	22
" 15½-15 "	12	6	11	13
" 15 -15½ "	54	24	77	28
	205	99	263	133

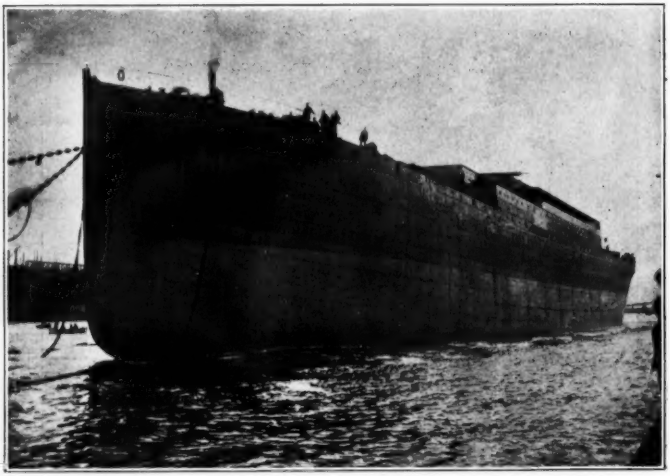
When one recalls that in the British fleet there are, in all, 7,534 steamers, he recognises that the proportion of vessels able to steam at a speed of more than fifteen knots is very small,—about one in thirty,—while the total of 394 vessels of all nations steaming over fifteen knots, out of an aggregate of 14,183, shows clearly that the tramp predominates. Indeed, for every vessel that exceeds twelve knots there are probably twenty that jog along at a slower rate. The north-east-coast ports, however, share the honours, so far as the building of steamers of large carrying-capacity is concerned. Belfast has done



THE HAMBURG-AMERICAN LINE TWIN-SCREW MAIL STEAMER "PENNSYLVANIA."
585x62x40 feet. 23,400 tons displacement; 6000 i. h. p. Built by Harland & Wolff, Belfast.

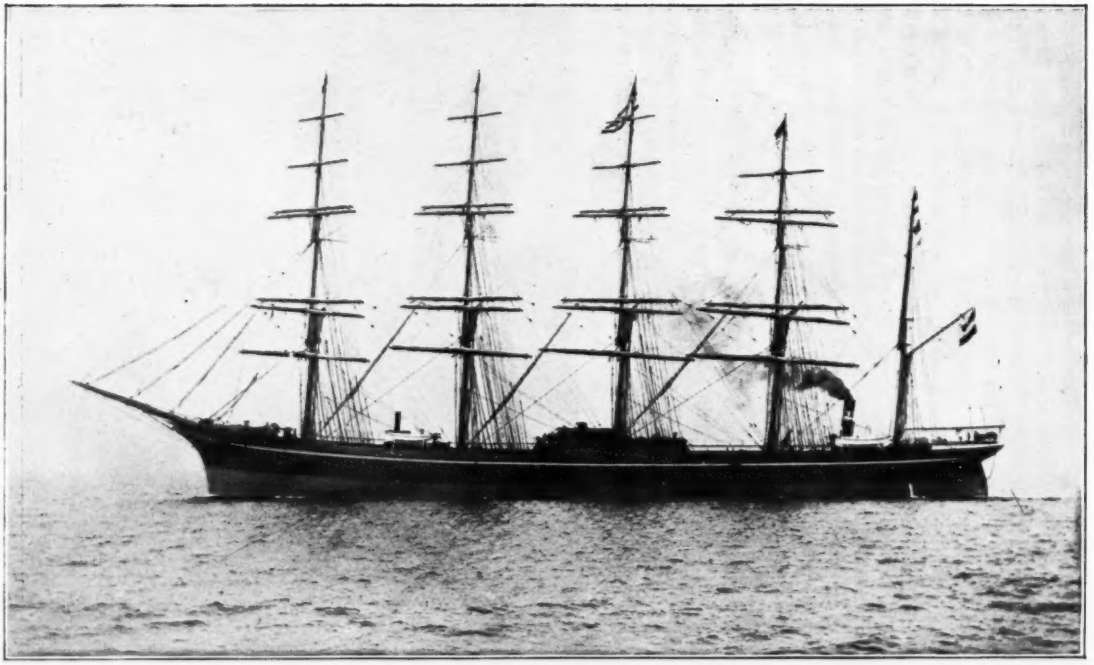
more lately in this respect than any other of the ports. In each of recent years the two firms there—Messrs. Harland & Wolff, and Workman, Clark & Co.—have built fourteen or fifteen vessels of more than 5,000 tons, the largest, the Pennsylvania, having a carrying-capacity of 14,000 tons. In the British fleet there are now, in all, 215 vessels whose tonnage exceeds 5,000 tons; the United States have 5, France has 17, and Germany 23. Curiously enough, however, the United States beat Britain in the number of large sailing ships. They have nine that exceed 3,000 tons register: Britain has only six.

No sailing ships are built on the north-east coast; the exception



THE LAUNCH OF THE "CYMRIC." THE VESSEL JUST BEING STOPPED.
Length, 599½ feet; gross tonnage, 12,340; 6500 h. p. Built by Harland & Wolff, Ltd., Belfast.

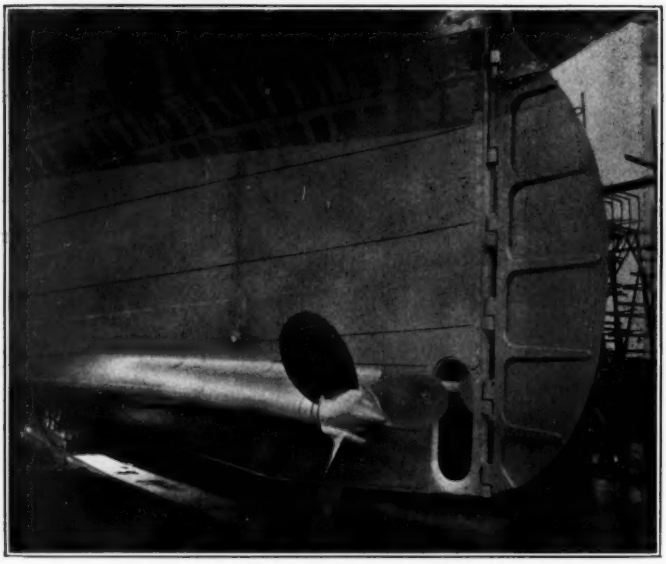
only proves the rule. That is not a matter of to-day, when the sailing ship is generally in poor demand: it has obtained for many years. Indeed, one or two firms on the Clyde seem to provide all the vessels of this class for Britain, notably Russell & Co., of Port Glasgow, although the old firm of McMillan, of Dumbarton, has produced some beautiful craft. Two of Russell's ships were exceptionally large. The Somali, a four-master built for Messrs. G. M. Steeves & Co., Liverpool, is 330 feet long, 47 feet beam, and 29 feet deep. The gross tonnage was 3,537 tons, and the deadweight carrying-capacity 5,500 tons. This vessel was excelled in size by the Maria Rickmers, which was the property of the well-known Bremen firm, but has



THE "MARIA RICKMERS," A TYPE OF LARGE SAILING SHIP. BUILT BY RUSSELL & CO., PORT GLASGOW. SHE HAS SINCE BEEN LOST.
Photograph by McLennan & Co., Greenock.

been lost. This vessel was 376 feet long, 48 feet beam, and 28 feet 4½ inches deep, her gross tonnage being 3,822 tons, and the dead-weight carrying-capacity 5,600 tons. But the largest sailing ship hitherto built is of German origin and ownership. She is named the Potosi, and carries 6,150 tons, her length being 426½ feet, beam 52 feet 6 inches, and depth 32 feet 9 inches. It is a question, however, whether so large ships are profitable. They are engaged mostly in the San Francisco, Australia, and nitrate trades. In the latter it is not infrequent for a ship to lie at one or other of the ports in the Pisagua range for three or five months, taking in cargoes in driblets from barges; so that the large ship is not profitable, unless, as in the case of the Potosi, she belongs to the nitrate merchant, who can hurry forward the process of loading, this being done in very many cases at the expense of other ships.

British owners have recognised the unprofitableness of the sailing ship, and, although Britain has not decreased the ratio of sail to total tonnage to the extent that some foreign nations have, because she is the carrier of the world and must meet all requirements, she has a great difference. At the beginning of the current decade the sailing ton-



THE STERN OF THE "CYMRIC" BEFORE LAUNCHING.

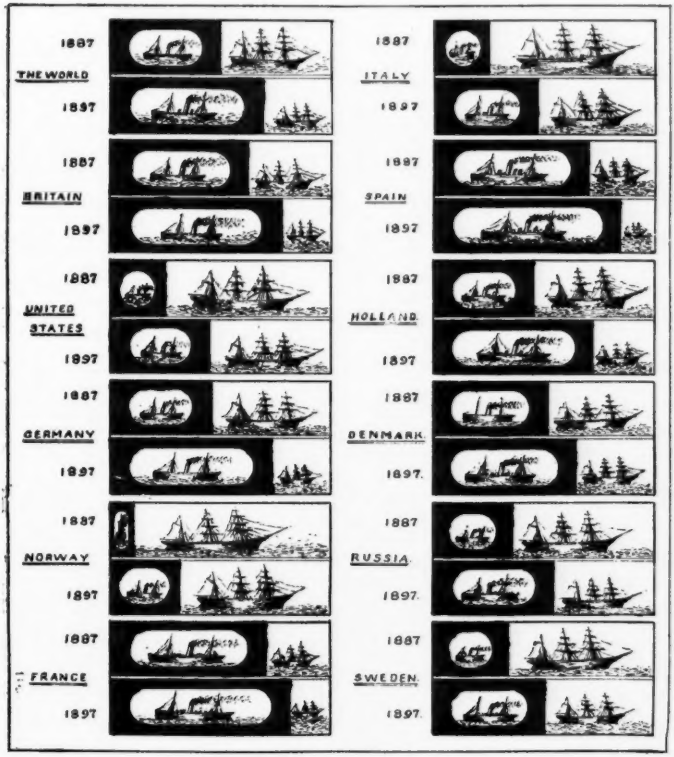


DIAGRAM SHOWING THE INCREASE OF STEAM AND DECREASE OF SAIL TONNAGE IN THE MARINE OF LEADING MARITIME NATIONS OF THE WORLD BETWEEN 1887 AND 1897.

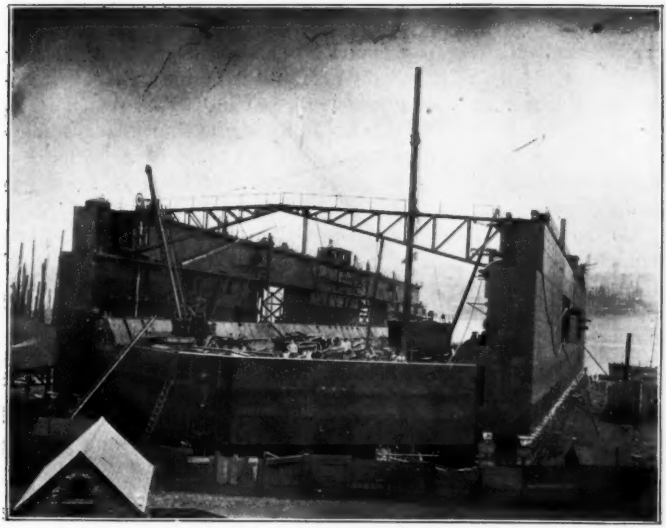
The proportion of black area to white shows the ratio of steam to sail in the countries and for the years indicated in the margin.

nage built averaged about one-fourth of the total merchant tonnage; it has dwindled to about a twentieth, although the contract price has decreased fifty or sixty per cent. In other words, the new British-built sailing tonnage in 1892 was 275,136 tons, while last year it was only 70,085 tons. Ten years ago Britain had 4,000,000 tons of sailing vessels in her fleet; now she has little more than 2,750,000 tons. The diagram on this page shows the difference in other fleets. It scarcely requires explanation. Each square represents the division of the fleet of a special country between steam and sail tonnage in 1887 and 1897. It would have confused the issue to have made the squares

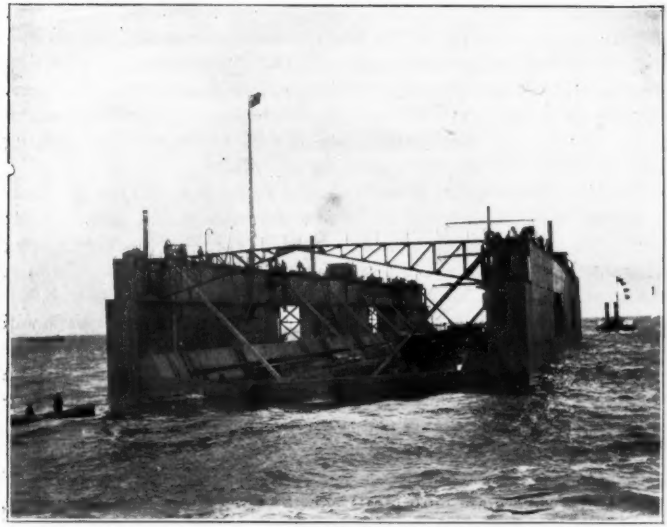
proportionate to the size of each fleet; as that has already been brought out, it is enough to indicate the change in the relative ratios of sail and steam ships. Thus we find that, of the world's fleet, 30.7 per cent. is sail, instead of 50 per cent. as it was ten years ago. This decrease is common to every country. In Britain it has decreased from 37.4 per cent. in 1887 to 21.3 per cent. in 1897; in the United States from 75 to 55 per cent.; in Germany from 54 to 25 per cent.; in France from 27.8 to 17.5 per cent.; and so on with the others, as shown on the diagram. France has the smallest ratio of sailing ships; Norway and the United States the largest.

Of course, the great factor in this change is the economy of steam-propulsion. Just as the compound engine made a great difference in the world's fleet, when British steamers displaced the sailing ships of the United States, so the triple expansion engine, with high-pressure steam, has involved a further curtailment of the sailing tonnage, and its practical disappearance seems only a matter of time. The north-east ports of England have been quick to recognise the change, although Belfast firms have profited most. The tendency is for low profits and a quick turnover, and thus one finds that the old firms still engaged in high-class work have to take a second place when mere tonnage-output is the standard. It is a misleading basis for comparison, for it is doubtful if the record-production, by a single firm, of 81,326 tons is equal to that of some of the firms returning 25,000 to 30,000 tons of warship and mercantile work with high-power machinery.

It is difficult to get accurate data of economic conditions in different districts; statisticians, as a rule, take a long time over their calculations, while the conditions are ever changing. Average earnings, too, are illusory, for, in one of the board of trade returns of recent years, it is shown that, whereas in London only seven per cent. of the workers are boys, in other districts the boys number twenty per cent. In Belfast, again, more unskilled labour is used; it is cheaper. But a return made lately does not show any material difference in wages of representative trades, except in the case of London. Thus pattern-makers got 36s. to 36s. 6d. per week on the Clyde, Barrow, and the north-east coast, 37s. at Birkenhead and Belfast, and 42s. in London. Joiners, again, had from 35s. 6d. to 36s. at Belfast, and on the north-east coast and the Clyde; 37s. 6d. at Barrow-in-Furness and Birkenhead, and 40s. to 41s. in London. Shipwrights had 37s. to 37s. 6d.; cabinet-makers, 36s. against 42s. in London; hammermen, 22s. to 24s. against 31s.; brass moulders, 35s. against 38s.; plumbers, 36s. against 42s.; so that it will be seen that London builders are placed disadvantageously. The difficulty is largely due to the high house rents and the distances between house and work. Of course, piece-work so



THE FLOATING DOCK ON THE WAYS, BEFORE LAUNCHING.



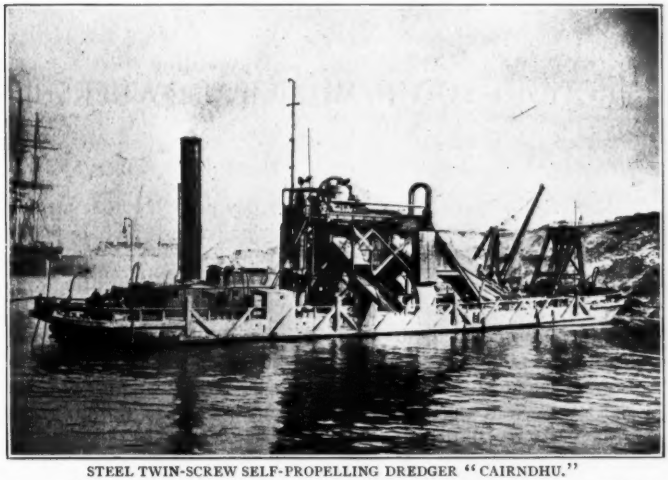
FLOATING DOCK FOR CUBA, UNDER TOWAGE.
Built by C. S. Swan & Hunter, Ltd., Newcastle-on-Tyne.

largely prevails that even the figures given are by no means applicable to all men; but the rates, usually determined by the omnipotent organizers of labour, are about the same for each district for similar work, excepting perhaps London. It would be easy to show that the rates have increased greatly in recent years; in 1896 fully a quarter of a million workers in ship-building works, etc., got increases averaging 1s. 6¼d. per week.

Concurrently with the increasing of labour remuneration, there has been a decrease in the price of the ships produced. Some part of this has been due to the introduction of machinery, although in this respect the British firms, owing to the domination of trade unionism, do not reap the measure of advantage accruing to firms in the United States. This, however, I shall refer to later. Part of the reduction in the selling price of ships means loss to the capitalist. The published accounts of several of the limited-liability companies prove the small return of capital from ship-building. It is significant to show the national gain resulting from the cheapening of ships.

For first-class tramp steamers the price in 1883 was £14 per ton; now it is about £10. For sailing ships the price is £5 per ton dead-weight,—from 50 to 60 per cent. less than fifteen years ago. When one recalls the preponderance of those two types, and the greater economy of the steamers, it is possible to understand the cheapening of products brought to Britain from over the seas, and the ability with which she can compete for the carrying trade of other countries, which, as I pointed out in my first article, is a great source of revenue. For vessels of the intermediate class, fourteen-and fifteen-knot steamers, with passenger accommodation as well as large cargo-carrying capacity, the cost has decreased from £18 to £15 per ton. For high-speed steamers it is difficult to give an average, for the specifications differ so much, as well as the accommodation and the fittings; but a typical twin-screw channel steamer, capable of twenty knots, with state-rooms, etc , costs from £40 to £45 per ton. Fifteen years ago this type was not in existence, the fast channel steamers being nearly all paddle-boats costing about £50 per ton. This, it will be seen, equals the cost of the high-speed Atlantic liners; but in those vessels the machinery necessarily is costly, to say nothing of the finishing of the passenger accommodation, in which art and elegance are important items, especially in view of the higher rates of wages paid.

I have not said anything of the special classes of ship-building,—for example, dredgers which make harbours suitable for shipping of great size. These are built mostly on the Clyde, by Messrs. Simons & Co., Renfrew, Lobnitz & Co., Renfrew, and Fleming & Ferguson, Paisley, although several of the largest of special types have been built



STEEL TWIN-SCREW SELF-PROPELLING DREDGER "CAIRNDHU."

200x37x12½ ft.; capable of dredging 1000 tons per hour from a depth of 40 ft. Built for the Clyde Navigation Trustees by Fleming & Ferguson, Ltd., Paisley, 1892.

at the Barrow works. The Cairndhu, built by Fleming & Ferguson for the Clyde trust, is able to dredge 600 tons per hour; she cost £23,900; her working charges are equal to 0.41d. per cubic yard. She can dredge to a depth of 40 feet, cuts out a channel ahead of her, and steams six knots; but her dredgings are discharged into separate hopper barges, which sail forty-six miles to sea, the cost of depositing at sea being 1.21d. per cubic yard. Dredgers fitted with their own hoppers may work more economically. Again, reference should be made to the floating deck of Messrs. Swan & Hunter, of Newcastle, which can take a ship of almost any length, of a width of 82 feet, of a draught of 27 feet 6 inches, and of 12,000 tons dead weight. The docking process takes at most two and one-half hours. The dock consists of five pontoons, with side walls, and electric pumps are fitted to fill the dock, and thus lower it below a ship. The draught of the dock then is 42½ feet with a freeboard of 4 feet 2 inches. This dock was built in six months.

I have refrained from any description or comparison of the equipments of the various establishments. There is a general similarity in the machine tools of the best work; inventories would not differ materially, and to discuss the conditions determining even such variations as occur would occupy undue space.

OBJECTIONS TO THE MUNICIPAL OWNERSHIP OF PUBLIC WORKS.

By T. Carpenter Smith.

AMONG the many questions of the day probably none attracts more attention than that of the municipal ownership of public works. So far, the evidence advanced, for or against, has been of the most *ex-parte* character, each contestant presenting only the reasons, figures, or results which will sustain his view of the question, and refusing to admit, as even worthy of consideration, the points brought forward by his opponent. That this style of argument is a very mistaken policy will not, I fear, lead to its abandonment, but we may lay down as a general principle that, in cases of this kind, the final result will generally be the correct one. We may, therefore, be sure that, the more freely and fairly every fact which bears upon the question is discussed, the sooner will the truth be arrived at, and the cheaper will it be, in the long run, for all parties concerned. That there is need that the matter should be brought within the intelligent judgment of every citizen can hardly be doubted when we find in Philadelphia to-day the extraordinary combination of a strong party, headed by many of the best citizens, urging the erecting and operating by the city of an electric-light plant, while the gas works, which have been owned and operated by the city for many years, are in such a condition of dis-repair and inefficiency that, in response to the demand of an equally strong party, headed by equally intelligent and public-spirited citizens, they have been leased to a private corporation for a term of years.

The demand for a city electric plant is one that is so general in the United States as to warrant the belief that there is some real reason in it. As it is with present conditions rather than their causes that we are concerned, we may, without going into the matter too deeply, point out at once that one cause of this has probably been the action of local electric companies themselves. Rightly or wrongly, they are generally credited with having made large profits, and the general suspicion of their use of political means to gain their ends has not improved their position with the public. When threatened with competition by other companies or the municipality, they have made the mistake of not laying bare to the public the true facts in the case. Instead of pointing out, as they generally could, that their profits have not been excessive, or, if large, are fully as honest as those made

in any other business, and that justice demands that their property shall not be destroyed without compensation, they have endeavored again and again to prevent competition by legislative enactment. In nearly every case these laws have been promoted and pushed in a manner to create public suspicion instead of public confidence, and so far, therefore, they have generally failed of enactment, and the companies are confronted to-day by a still more bitter feeling against them. Meanwhile the cities have been the victims of visionary theorists, unscrupulous politicians, and greedy promoters, who know little and care less about the true costs of the schemes they propose, but who desire either to pose as public benefactors, to gain political favor, or to earn the wages of go-betweens. The constant report of wonderful results (with half the data necessary for an honest decision left out) always gains a large number of honest supporters, who lend the necessary character to what we may almost call a craze.

The first step towards clearing away the haze surrounding the question is to recognize at once that there is a very great difference between municipal ownership of public works combined with municipal operation, and municipal ownership of works operated by an independent concern under municipal control by lease, contract, or other suitable arrangement.

I do not, in this paper, purpose going into this very wide question, but shall confine myself strictly to the division of it which is at present the most interesting, because the most common,—namely, shall a city put in and operate a gas or electric light plant?

To consider broadly the question whether a municipality should own and operate its own gas or electric light plant, we may examine it under three great heads. First, has a municipality the legal right to do this? Second, has it a moral right? Third, is it good policy? Under each of these heads subdivision is necessary, to distinguish cases where there is a plant operated by private parties, the value of which would be either destroyed or depreciated by the competition of the municipality, and, further, to distinguish between municipal lighting of the streets and public properties only, and the business of furnishing light to all who desire it. All these various divisions and sub-divisions can be easily followed by reference to the table appended.

The legal right it is useless to consider here. The whole matter depends purely upon the charter of the corporation, and the way in which it was received; and, being a question of law, it will be decided by the courts, from which there can be no appeal.

Under the head Morality, the case (A) where there is not already a company in existence and the plant is to be used for public light-

ing only is so largely the same as the cases (C and E) under the head Expediency that we may dismiss it for the present, and consider first the case (B) where, with no other company in existence, the intention is to use the plant for general commercial lighting.

- LEGALITY: Not open for discussion.
- MORALITY:
  - No Local Company, already operating.
    - Plant to be used for city purposes only. (A)
    - Plant to be used commercially. (B)
  - Local Company, already operating.
    - Plant to be used for city purposes only. (C)
    - Plant to be used commercially. (D)
- EXPEDIENCY:
  - No Local Company, already operating.
    - Plant to be used for city purposes only. (E)
    - Plant to be used commercially. (F)
  - Local Company, already operating.
    - Plant to be used for city purposes only. (G)
    - Plant to be used commercially. (H)

A city being organized for the purpose of carrying on ordinary municipal business, it is not a part of such business to engage in manufacturing or other pursuits for the purpose of making money. The ideal municipal government is that in which the expenses of government are exactly covered by the taxes, and in which the city has, so to speak, no profit or loss to show at the end of each year. Now, any commercial business is carried on either at a profit or at a loss. If the city's business of gas or electric lighting is to be carried on at a profit, then those citizens who use gas or electric light will be charged a high price for that light, in order to pay a profit, not only to themselves, but also to those who do not use it. If the works are to be carried on at a loss, then the citizens who do not use the gas or electric light will pay taxes to furnish a convenience or economy to those citizens who do use it. If the works are to be operated exactly at cost, then the city will carry on a business from which it will get

nothing, but in which it will have to take the labor and risk incident to such a business in order to benefit some only of its citizens, furnishing a commodity not desired by all. It is evident that in such case the city should not engage in such work at all, unless we desire to create a Socialistic system.

At this point we are confronted by the argument constantly brought forward that the furnishing of gas and electric light to the citizens stands on the same footing as the furnishing of water, and that the same reasons may be urged for the city's ownership of gas or electric-light plants as for its ownership of water works. The cases do not seem parallel. Let us look at some of the chief reasons why the city should own water works. First, there is no substitute for water, which is an absolute necessity of life. The city may, therefore, plead an obligation to see that each inhabitant has a means of getting water, and also that each citizen pays for his use of it. It may be here mentioned that in some cities properties are taxed for water, whether they have a connection with the pipes or not, the ground being taken that, as water is a necessity, the occupants of such property must use their neighbors' water-supply. It may be urged that the citizen who has a private means of supply should not be taxed, since he can use this, instead of taking water from the city; but here the question of public health steps in. Experience has shown that such means of supply, to be perfectly healthy, must be far beyond the reach of the ordinary citizen, and that to allow the indiscriminate use of what individuals may consider suitable for their purpose will most certainly result in sickness, which will affect not only the individual, but the community at large.

Again, the water-supply of a city is constantly required and used for fire protection, and since, for this application also, no general substitute has been found, adequate protection requires that each and every house shall be secured against fire. This function is, in fact, a branch of the police power, which forbids a man to do things dangerous to himself, lest they may endanger his neighbors.

As against the fact of there being no substitute for water, we have a great choice in methods of illumination. One man may prefer coal oil, another may prefer gas, and another may prefer electric light. Experience has shown us that all of these may be made measurably safe, and the only fair way, therefore, in which to supply this want of the citizen is to allow him the freest selection, while placing the general serving of the commodities under strict regulations as to safety. Thus we find, in nearly all cities, ordinances providing that no oil must be sold below a certain flashing point, that the piping in buildings must be thoroughly tested before it can be used for gas, and that

electric light wiring must be done under certain rules to prevent danger to life, while behind all these stand the insurance companies with their requirements, of even greater strictness. There is, therefore, no pressing necessity for the city to engage in the business of supplying either oil or gas or electric light to the citizens, and we may fairly conclude that, on the score of morality, the decision is against it.

Coming now to the case (C) where there is already a plant operating in the city, and it is proposed to erect a municipal plant for public service only, we may partly consider with this the former case (A) of a municipal plant for public service only in a city not already having a company. I believe that there can be no moral objection to municipal ownership and operation of a plant of any kind if used exclusively for the needs of the community as a whole, provided always that the city has not, by direct or implied contract, caused the local company to invest capital in apparatus or property to be used for the purposes of the city, the value of which would be destroyed or depreciated by abandonment of the contract by the city. It must be distinctly understood, moreover, that it is not at all necessary that there should have been a formal contract for a term of years; a mere assenting of the city to such investment by the local company constitutes a moral obligation on the part of the city to either maintain such contract, purchase or pay for such property or apparatus, or give such notice of termination of the contract as will permit the company to gradually dispose of, or retire from use, this material without undue loss.

Coming to the case (D) where it is proposed to apply the city plant for general commercial lighting, we at once see that not only does every argument which applied in the case of the last sub-division hold with equal force in this, but we have in addition a new set of conditions, and new arguments to apply. In the first place, the city would be using its total power to compete with a part of itself; it would be in the position of having granted a franchise upon which large sums of money had been spent and investments made, and then proposing to destroy or seriously injure it, and it would be entering upon a course which was certainly not contemplated when it received its charter for the purpose of exercising municipal duties. If it be right for a municipality to enter into the business of supplying its citizens with gas or electric light, then it is equally right for it to enter into the business of supplying coal, or dry goods, or any other commodity, and, as said above, this it cannot equitably do unless we wish to establish a Socialistic community. Under the conditions under which nearly all gas or electric-lighting companies have been established, for the city to establish a competing plant would be dis-

honorable in the extreme. The argument is often made that the city has presented these companies valuable franchises for which they have not received adequate return, and that this is sufficient reason for not making any compensation to the companies for now injuring them; but it certainly is a new idea in morality that, when a contract disappoints, it may be disregarded without penalty. It must be remembered that, at the time these franchises were granted, it was a very uncertain question whether the business would ever pay; so much was this felt to be the case that in some cities there are laws still existing which give the first company entering into the business of supplying gas or water an absolute monopoly within certain districts. It is true that, when it was decided in Pennsylvania that electric-light companies did not come under this general law, the legislature refused to grant such monopolies to the first companies which had received charters, and left the field open to all, but it must be remembered that this decision was not arrived at until electric lighting had been for many years an established business, and had proven that it was likely to be a success. That it has not been such a success as was anticipated the books of nearly every electric-light company will show. If the history of many gas companies now paying well were gone into, I suspect a good many would show in their early years—now buried and forgotten—an awful record of anxiety and loss. There is greater reason for competition among water companies than for competition among gas or electric-light companies, since, as already said, water is a necessity for which there is no substitute, and the temptation to make the monopoly oppressive is therefore very much greater than in either of the other industries. Clearly in this case a municipal plant would be not moral.

Under the head Expediency, we will reverse our order of consideration, taking first the sub division (H) where a company is already in existence and operating, and the city plant is to be used for the general supply in competition with it. We may say at once that this would not be expedient, since it would be (as shown under the consideration of D) not moral, and for a community at large nothing which is not moral can be expedient. This will equally apply to the case (F) where there is no plant, and the city proposes to do commercial lighting, which we have shown to be not justifiable in case (B). Dismissing these, we may consider the case (G) where the plant is to be used for public lighting only; here a great number of points have to be taken into consideration. If the city has been receiving light from the company and has to pay it some compensation for the withdrawal of the city's patronage, the chances are that the city's plant will cost it as much as the similar plant put in by the company,

the compensation payment more than making up for any fall in prices of material since the original installation. As to operating cost, the chances are that this will be greater for the city than for the private plant. There are undoubtedly cases where municipalities do operate both gas and electric-light plants and secure their lights at lower rates than they can obtain from a local company, but it is equally true that these cities can lease their plants to an operating company and make more profit than by operating themselves. Moreover, as the public lighting for a city is generally but a small amount of the total lighting done by the company, it is only reasonable to suppose that the cost per lamp will be less for a large number of lamps than for a small number, and that consequently the city could buy its service from the local company, under a truly equitable contract, at less real cost to itself. By this means also it at once cuts off an uncertain element in its expenses, and knows that for a certain sum per year it can receive certain service. That this is an advantage in making the tax rate can hardly be denied.

The other considerations in determining the question of expediency apply equally well in the case (E) where there is no plant operating in the city; accordingly, we may now take this item into the discussion. The average electric-light station which is confronted by the question of a municipal electric-light plant usually founds a great deal of its argument in opposition upon the supposed fact that a municipality cannot operate a plant as cheaply as a private corporation can. This form of statement is a mistake. There is no reason why it cannot, though there is little doubt that, as a rule, it does not. We cannot, however, by faulty experiments, disprove a law, and accordingly we may as well at once point out wherein it is that municipalities do fail in cheap operation, and where they could, or could not, amend this state of affairs. In the first place must stand, of course, the well-known fact (gloze it over as we may) that in America, at least, average city employees are neither as competent or as honest in their work, and do not do as much for the money, as those employed in private corporations. Again, the temptation to use the patronage of the city business is a constant source of corruption among city officials.

It is not many years since the *régime* of the "Gas Ring" in Philadelphia, which was so notorious as to be selected as an example in Bryce's "American Commonwealth"; and it is this order of things, bettered a little, that a large number of citizens are supporting.

To offset these sources of excessive cost, the temptation is to furnish returns which are not correct, making no allowance for interest

on cost of plant, charging no taxes against it, not making allowance for the water furnished to it by the city, making no allowance for depreciation of machinery, perhaps providing no sinking fund to take up bonds which have been issued to pay for the plant, charging nothing for wages because the men who already operate the water works also operate the electric-light plant, etc.,—all or any of which omissions may deceive those who have not ingrained in their mind the principle that you cannot get something for nothing, and that all work done must be paid for somehow, though it may not appear in the bill at first sight.

Of course the ready answer to this is that the city's business in every department should be as well administered as that of a private corporation (which, in fact, a city is), and its employees should be selected purely for their fitness, and held to a strict accountability for the proper performance of their duties; and objectors are continually invited to witness the magnificent results which, under such conditions, have been attained with civic plants in Europe. While excellent results are undoubtedly attained there, it is a question whether the best results of all have not been reached in those cities which, owning public franchises, leased them to corporations, or even granted the franchises bodily to outsiders, making with them strict contracts for regulation of the service. Moreover, we have to deal with circumstances as they are, and not as we should like them. After all, the real cure is to get the public service into the hands of competent and honest workers, and the greatest obstacle in the way of this consummation, so much to be desired, is without doubt in the United States the present office-holder, and the man who puts him there. It is too often true in America, and perhaps elsewhere, that the member of the governing body of a city, who takes his place without salary, and who is (as very often happens) a man with practically no business, holds this office for "what there is in it." His ability to be elected depends largely upon the number of places that he can control, and to cut off his possibility of appointments removes the chief reason of his being in the position. He will not stay there for glory, and with his departure goes the greatest hindrance to honest and effective administration.

And now what are we to consider the best method of avoiding these various troubles? To the municipalities, on the one hand, whose vision has been dazzled by the prospect of escaping from the thraldom of a company supposed to be charging excessive prices, and putting in a plant which shall be the only plant in the country to make no mistakes, cause no corruption or jobbery, and so turn in a handsome profit to the taxpayers, and to the gas or electric-light company which

sees its business threatened, its investments in danger, and itself continually held up to public odium, some just and equitable settlement naturally seems a desirable consummation.

Many years ago, among electric-light interests, I strongly advocated the formation of a commission for this end, not knowing at the time that the gas and electric-lighting commission of Massachusetts was filling this very purpose.

To those who urge the difficulties usually met with in commissions I say that much of this comes from the character of the men chosen. Such a commission must consist, not of politicians, or lawyers, or legislators, whose very connection with the case will make the public suspicious, or of professors and teachers, who have too little experience of the practical side, but of the very best business men and manufacturers in the community, for only men of this kind can fully appreciate the circumstances. They must be men to whom can be opened the books and the whole history of the contracting parties. They must be men of such reputation and standing that, when they state their verdict, whether the compensation is to be one dollar or one million dollars, the community will accept it absolutely and without hesitation. They must also be men of such character and position that, no matter what the public misunderstanding of their finding may be, they can bear the responsibility. I do not expect to get good results, at least under existing American conditions, from a commission whose members will serve without pay, or for a mere pittance; I would take only men whose services can demand high salaries, of which the State or city should pay half and the companies affected the other half. It will be a small price for either side to pay, compared to the interests at stake.

Lincoln once said that you "can fool all of the people some of the time," but the time has gone by when all the people can be fooled on the question of gas or electric-light monopolies, and it behooves all concerned to use their utmost endeavors, lest the swing of the pendulum shall work their destruction, grossly unjust perhaps, but none the less overwhelming.

THE EQUIPMENT AND ORGANIZATION OF A CITY FIRE DEPARTMENT.

By Hugh Bonner.

THE occurrence of a great city fire is usually, and not unnaturally, productive of the keenest interest and the most active discussion, often continuing long after new structures have risen upon the ruins of the old ones.

The property interests involved are so large, and the menace to life so great from fire in thickly-built districts, that attention is deservedly drawn to two great systems of safeguarding: first, systems of architectural construction which will make it extremely difficult for a building to take fire, or, if fire be started, to burn with rapidity; second, the most carefully organized and highly efficient system of confining and extinguishing a fire.

European cities are generally distinguished—strikingly so to an American—by the development of the former principle. In the United States, on the other hand, the chief dependence in most cases is now, and for some time must be, the efficiency of the fire department. While the heavy insurance losses on American risks and the proportionately high rates which are general, in spite of the highest organization of the protective service, suggest that prevention should coöperate with control, the recent great disaster in London has awakened active interest in the maintenance of a fire-fighting force which shall be adequate to any emergency arising in the largest cities.

It will be of interest, therefore, to study the system of organization and equipment of a typical American fire-brigade, and I shall take for an example the fire department of New York, as it existed at the end of 1897.

The fire department of the city of New York has an aggregate of 1,146 officers and men, divided into 61 engine companies, on land, 3 companies on fire-boats, and 22 hook and ladder companies, a total of eighty-six companies. The number of men assigned to each varies with the locality, but does not exceed a total of 12 (including two officers and two engineers) except in nine engine companies, which are classed as double companies, with the necessary complement of men to operate two sets of apparatus. Each section of these double companies is really a company in itself, and, in the absence of one section, the other performs duty in the territory thus left vacant. The same conditions apply to one hook and ladder company, which has a double set of apparatus, officers, and men, the second section being

classed the same as the second section of a double engine company and either assigned to cover the ground during the absence of a regular company, or held in reserve during large fires. Attached to some of the hook and ladder companies are chemical engines, which operate in the districts of the hook and ladder companies, but have an extra force in charge of them.

The department is divided into fourteen battalions, with from five to eight companies in each. The battalions are again ~~sub-divided~~ grouped into three sections, and assigned to the command of a deputy chief of department, the whole force being under the direct command of the chief of department. The uniformed force consists of the following officers: chief of department, three deputy chiefs of department, one chief instructor, fourteen chiefs of battalion, eighty-six foremen, ninety-six assistant foremen, and the necessary complement of engineers,—two to each company, except in the double companies, each of which has four.

The chief of department is directly responsible for the management and discipline of the entire uniformed force and for the extinguishment of fires, and in turn is responsible to the board of fire commissioners, which body consists of three citizens, appointed by the mayor, for terms of six years each.

The duties of a deputy chief of department are to assume command in the absence of the chief of department, enforce discipline in each battalion under his charge, make inspections of the officers, men, uniforms, apparatus, horses, quarters, etc., and see that all officers are efficient in their duties.

The duties of a chief of battalion are to assume command of his battalion, regulate all the details therein, enforce discipline, visit the several company quarters in his battalion district, supervise the extinguishing of fires at which he arrives first, and forward to headquarters each morning all official papers, reports of operations at fires, etc., through the headquarters of the deputy chief to whose district the battalion belongs.

Each company has a foreman and an assistant foreman. The former is the officer in command, and is responsible for the control of his men, uniforms, discipline, etc., as well as horses, apparatus, tools, implements, and public property of all kinds entrusted to his care. He makes a return of this property annually to headquarters, and a proper record is kept. To each company is allotted a section of the city, which is classed as a company district, and for which the commanding officer is responsible. He is required to see, so far as details are concerned, to the enforcement of all laws relative to prevention of fires, storage and sale of explosives and combustibles, alterations

in buildings, exits and entrances, iron shutters, the care and condition of hydrants, obstructions to fire-escapes and their condition, the condition of streets and avenues, and every matter pertaining to the fire department. If it is not within the power of the commanding officer to correct any existing evil, he must immediately take action by forwarding the necessary reports to headquarters with a view of abating or remedying the evil at the earliest moment. He is also required to make a report each morning after roll-call at 8 o'clock A. M., and to transmit the same to his battalion chief, showing

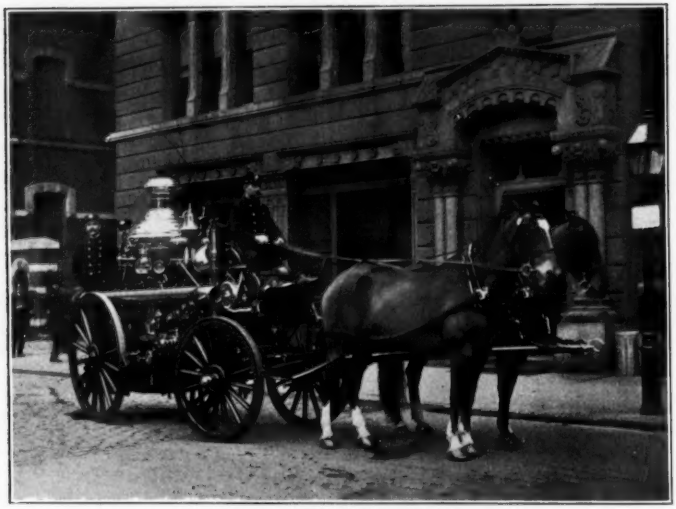
A THREE-HORSE FIRE-ENGINE OF THE NEW YORK DEPARTMENT.

the exact number of men ready for duty, those who are absent and for what cause, reports of operations at fires, etc.; and these are in turn transmitted to the deputy chief of department, and by him to the chief of department at headquarters, where all such reports are consolidated and a record kept for future reference.

Engine companies are equipped with engines of a capacity of from 350 to 1,100 gallons per minute. The heavier engines are arranged to operate with three horses, and weigh, when ready for use, about 11,000 pounds; those of smaller size are usually located

in the suburban district, do not weigh, when ready for use, more than 5,500 pounds, and, as a rule, are equipped with two horses. The engines are complete in every respect, and, while standing in quarters, are connected to a heater in the cellar, which permits a circulation between the two boilers with the object of keeping on the engine boiler from 5 to 25 pounds of steam, which is necessary in all cases to give a prompt water-supply at fires in the vicinity of company quarters. The engines have tool-boxes containing all the tools used on pumps, machinery, and boilers. Ash pans with space sufficient to carry fuel for an hour's duty are on the back of each engine.

Hose wagons are drawn by two horses, and are equipped with 1,500

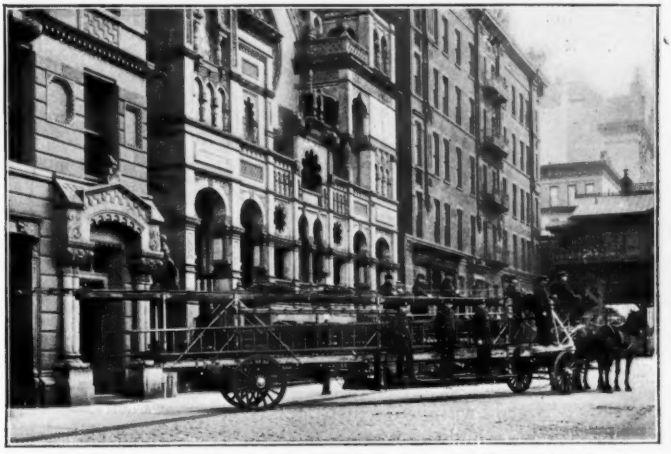


A TWO-HORSE FIRE-ENGINE.

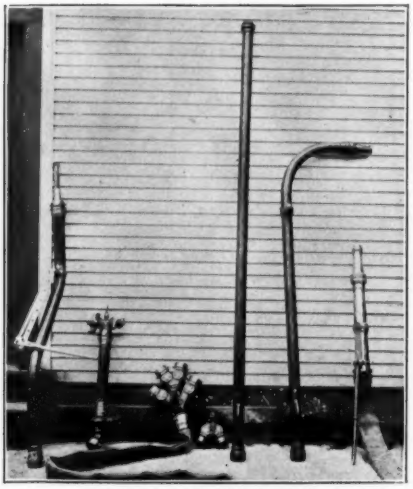
feet of hose, a section of large tapering hose, two scaling ladders, life lines, life belts, life gun, life net, roof rope, wrenches, siamese, pipes, nozzles, and hose hoisters. The hose varies in size from 1½ to 2½ inches in diameter. Hose wagons of the first size attached to engine companies carry 1,000 feet of three-inch hose, 500 feet of 2½-inch hose, and 600 feet of 1½-inch hose. The small hose is generally used at small fires, while the three-inch hose is used on larger fires or where more than one alarm is necessary. The wagon carries all the men, and follows the engine to the scene of the fire. The hose wagons are supplied with rubber hose and rubber-lined cotton hose, and, after use at a fire, the wet hose is replaced by dry.

A NEW YORK FIRE DEPARTMENT HOSE WAGON, CARRYING SCALING LADDERS.

A hook and ladder truck of the first size is equipped with an 85-foot extension ladder, carried on a frame, with the butt resting on a turntable; the ladder is elevated by the use of cranks on each side. An aerial ladder can be elevated to a height of 85 feet in about one min-



HAYES HOOK AND LADDER TRUCK WITH EXTENSION LADDERS.

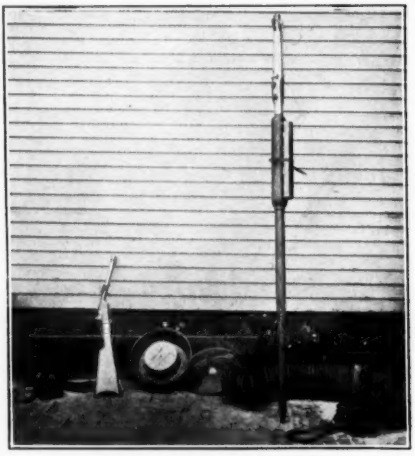


GROUP OF HOSE CONNECTIONS.

Cellar Pipe. 4-way Connection. Sub-cellar Pipe. Distributing Nozzle. Siamese. Street Pipe.

ute. The other ladders vary in length from 10 to 50 feet. The truck is also equipped with scaling ladders, life lines, life belts, tools and implements, such as hooks, axes, mauls, augers, saws, hammers, cellar and sub-cellar pipe, spherical nozzles, two-way siamese, 4-way siamese, 3¼ inch hose-pipes, nozzles, roof lines, hose hoisters, ball and chain, battering ram, door-opener, wall-cutter, tin-cutter, life gun, rope ladders, claw irons, tapering hose, and fire extinguishers.

Chemical engines, which in a number of cases are in use with hook and ladder companies, are drawn by two horses, and carry two sixty-gallon tanks of fluid, resting on an iron frame. When equipped and loaded, they weigh about 5,000 pounds, and are made ready for use, when they arrive at fires, by turning the sulphuric acid carried in a jar inside of the tank. The acid, when mixed with the soda, generates a pressure in the tank which forces the fluid through a small hose, and throws it on the fire. The water thus charged with carbonic acid gas is highly efficient in holding in



LIFE-SAVING APPARATUS.

Life Belt. Life Gun. Large Life Gun. Life Line.

The large life gun, which is shown with line attached ready for use, will throw a line 1000 feet high.

check and extinguishing a fire of considerable magnitude. The chemical engines are generally used in dwelling or suburban districts, or in districts where the water-supply is scarce, or where there are not enough engines to cover the district.

THE HAYES TRUCK, WITH LADDER EXTENDED.

Three water towers are used in conjunction with the hook and ladder companies, and are operated by an extra force of men assigned to those companies. The towers are drawn by three horses, and are constructed to receive from two to six streams of water on each side of the frame. These streams are discharged into a reservoir and then

SCALING LADDERS, AS USED BY THE NEW YORK FIRE DEPARTMENT.

through a 3½-inch hose, which passes through an iron frame about 25 feet in height, and which is elevated to a perpendicular position by water-pressure. There is also a 50-foot extension-piece, which operates within this frame.

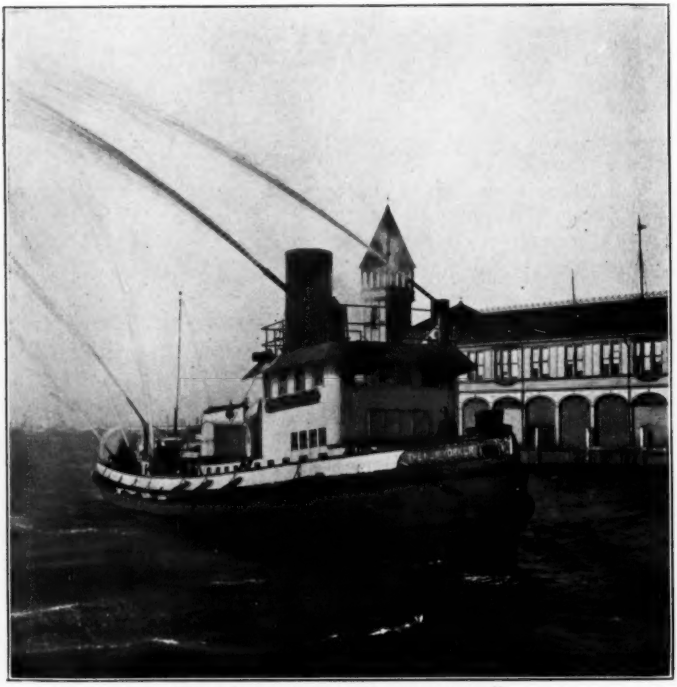
The streams thrown by the water tower vary in size according to the supply furnished to the reservoir, depending for this on the number of engines which can be spared for this duty. The object of this stand-pipe is mainly to operate in the upper part of the building; for

ONE OF THE CHEMICAL FIRE-ENGINES OF NEW YORK.

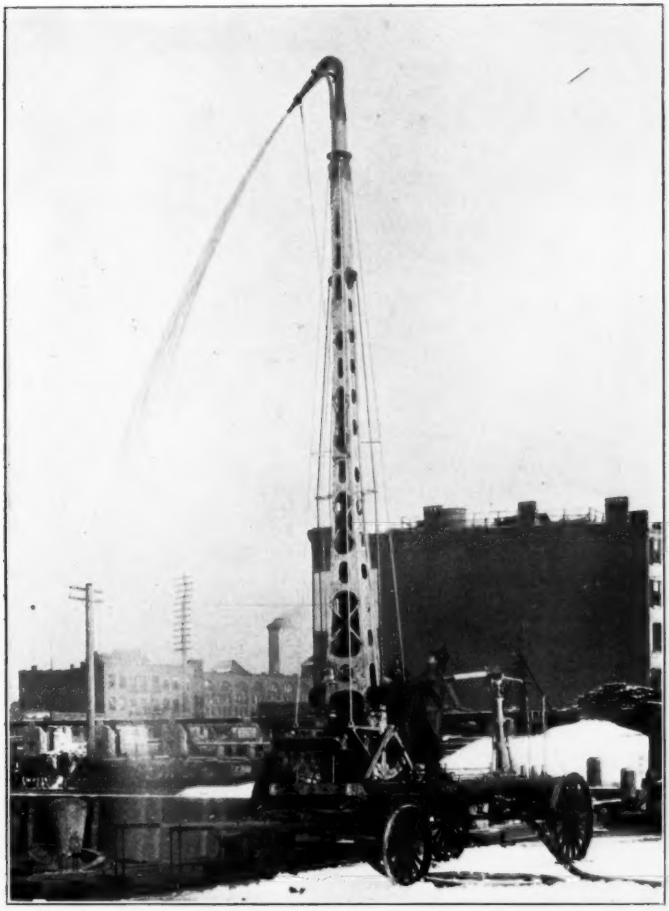
THE WATER TOWER, LOWERED FOR MOVEMENT THOUGH THE STREETS.

such a situation, it affords a convenient and efficient means by which great quantities of water can be discharged when the extent of the fire warrants it. There is also a deck pipe attached to these towers, about six feet in height, connected to a similar reservoir, and fed in a like manner; it is operated from the deck of the tower by the use of a lever. Streams from this pipe can be utilized in the cellar, the top floor of a building, or may be directed toward any point of the compass, and are mainly used on the lower floors directly under the streams from the stand-pipe.

The fire boats are three in number, with capacities of 2,500, 3,500, and 13,000 gallons per minute, and are located on the East and North rivers, and at the Battery, and perform duty on the river-fronts in protecting the large piers and shipping, as well as on land to a distance of 1,000 feet from the bulkhead line. They are equipped with hose 2½, 3, 3¼, 3½, 4, 5, and 6 inches in diameter; there are

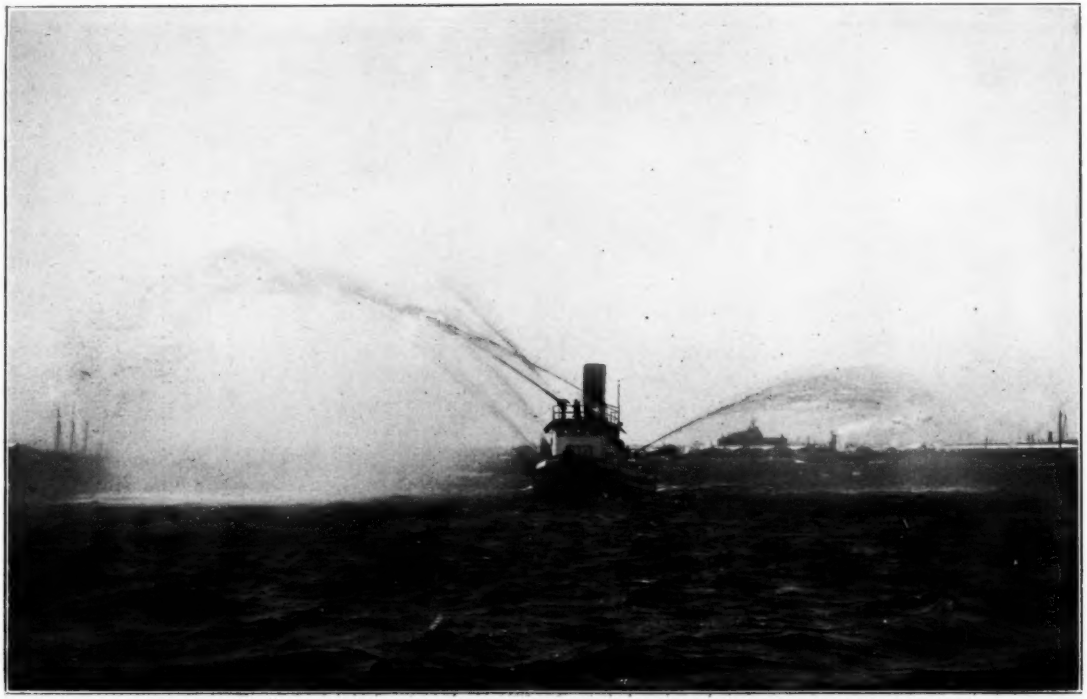


NEW YORK FIRE BOAT "NEW YORKER."



THE WATER TOWER, RAISED AND IN OPERATION.

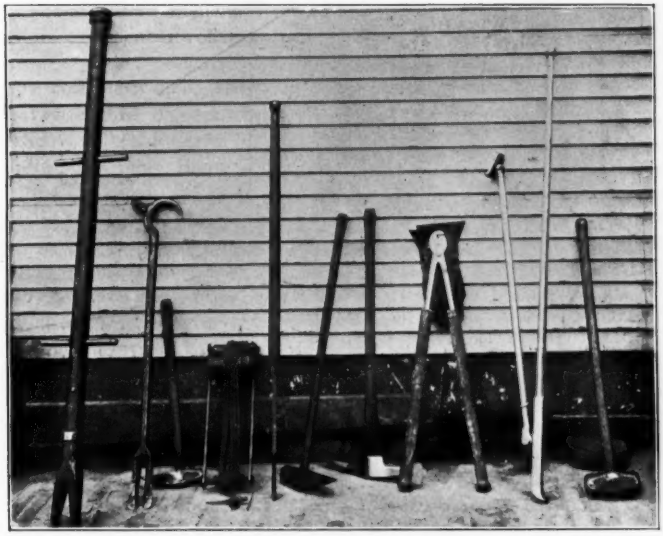
swivel nozzles on deck and on top of the pilot house, and discharge gates on pumps from sides and fore and aft, with the necessary complement of pipes, nozzles, and wrenches for all sizes of hose. Two of these boats have hulls and upper bulwarks of steel, and are fully capable of entering any bulkhead or side of a pier, no matter how hot the fire. They are intended for such emergencies, as well as for re-



THE "NEW YORKER," ONE OF THE FIRE BOATS OF THE NEW YORK DEPARTMENT, WITH ALL STREAMS PLAYING.

moving burning vessels from their berths, and hauling them to places of safety.

The boats often receive alarms for fire on shipboard, from vessels that have reached the Highland Lights, going to, or returning from, sea voyages; they go to meet the vessels, and take entire charge of the extinguishment of the fire before the vessels reach their docks. The boats are also available for duty on either shore, when called for by the authorities. They are manned by one foreman, one assistant foreman, three engineers, two pilots, three stokers, and eight firemen.



GROUP OF TOOLS CARRIED BY A NEW YORK HOOK AND LADDER COMPANY.

Battering Ram. Maul. Tin Cutter. Pick Axe, Door Opener.
Lock Opener. Hose Hoist. Cutting Maul. Electric-Wire Cutter. Sledge.

The fire-alarm system receives at the central office all alarms from the various boxes or stations, which are marked by a red lamp. The alarm box is attached to the lamp-post, and has a keyless door. On its face is a brass knob; also its number. Turning of the knob operates an automatic gong in the door, which announces to those in the vicinity that the box is being opened. From the front of the inner box a hook projects, and the pulling down of this hook once and letting it go starts the machinery in the inner box, and registers at

FIRE-ALARM BOX WITH INNER DOOR OPEN.

the central office the number indicated on the face of the box. This number is immediately re-transmitted from the central office by a repeating instrument, which transmits the signal over the various circuits to the companies which are to respond, as shown in the table on page 805.

The inner box contains a Morse key, a small armature, and a small gong. The Morse key is used when additional help is required, after the arrival of the first company at the scene of a fire. The officer in charge, if, in his judgment, additional companies are required, directs the sending of a second alarm, which is sent by Morse key from the box to the central office, the signal 2–2 being followed, say, by Station 8 6, which indicates that all the companies on the second line for station 8 6 are to go to that station. Should still further help be required, a third alarm is sent, the signal 3–3 being followed by station 8 6. The 4–4 and 5–5 alarms are sent similarly. Then, if additional help is still required, the simultaneous call 9–9, station 8 6, 3–3,–3 7 9, is sent. This will bring all the companies assigned to the station at Broadway and Twenty-fifth street on the third alarm to Worth street and Broadway, and the same course may be pursued in any section of the city where the companies are still in quarters. Companies may also be called singly by the special call signal system. When all the companies are called by the fifth alarm for station 8 6 and are on duty, the city is still protected by reserve companies, as well as those moving to various quarters. For instance, the order E. 13 to E. 7, means that second section of Engine 13, at Wooster and Spring streets, shall proceed to quarters of Engine Company 7, at Chambers and Centre streets, and cover the ground left vacant by the absence of Engine Company 7 at the fire. The

order H. 5 to H. 1, means that the second section of H. & L. Co. 5 shall go to the quarters of H. & L. Co. 1, Chambers and Centre streets, and cover the district left vacant. In this manner the outlying companies are gradually brought closer to the scene of large fires, so that, in the event of one or more fires at the same time, the city as a whole has protection by the use of the reserve sections, which, as a rule, are not used at the first fire, but are held in reserve.

In addition to the street boxes, there are a number of special boxes in public institutions, theatres, hotels, academies, colleges, and schools, which are in direct communication with the central office. An alarm from one of these boxes calls to the building two or more companies, and a chief officer. The central office is also connected by automatic signals, with a great number of mercantile houses. The law requires that public buildings, institutions, hotels, apartment-houses, colleges, etc., shall be connected with an alarm system in direct communication with the central office.

INTERIOR OF MAIN FIRE-TELEGRAPH OFFICE AT HEADQUARTERS, NEW YORK.

On the left, in the background, is the key-board, each key indicating a separate circuit, on which alarms are received. The smaller instruments on the centre tables are used for transmitting first alarms to the companies assigned for response to each box. The large instrument to the left is reserved for second, third, and special alarms. Opposite to the key-board is a switch-board, (not shown) by which the circuits are constantly tested.

MANNER OF USING THE LIFE NET.

The fire alarm system south of One Hundred and Tenth street, with few exceptions, is entirely underground, the department having for its use separate conduits in the underground system. From these conduits special lines are laid to the various boxes and engine-houses throughout the city, so that, in the event of a gale or severe snow-storm, the underground system can be relied upon in transmitting alarms.

The companies are assigned in the regular order of distance from their quarters to the locality indicated. If from any cause they should fail to arrive in such order, they are required, in forwarding their reports of operations to headquarters on the following morning, to state the cause of such failure, and also answer a set of questions. This is a record of the operations of the company, and is also a part of the records of the department. The action of every officer and man on duty at an alarm of fire is a matter of record, as well as the duties performed by the companies, and a copy is sent to the headquarters daily. The responsibility in all cases commences with the first officer arriving, who must assume command of the fire until the arrival of a superior, who in a like manner assumes command until relieved by some one higher in authority.

Stations.	Engine Cos.	H & L. Cos.	Deputy Chief of Depart.	Chief of Bat'al'n	Water Tower.	Company to Supply Fuel.	From Fuel Depot.	Companies to Change Locations.	Reserve Force.		
									Engine Cos.	H. & L. Cos.	Ch'fs of Bat'al'n
84	27, 31, 7	8, 1	L	2, 1	1	Eng. 27	No. 3	.....	27, 31	15	4
* West Broadway and Worth St.	29, 12, 30, 13, 9	10	....	5	..	" 29	" 2	.....	12, 10	6	6
	55, 6, 4, 32, 20, 24	20, 9	....	3	..	" 55	" 6	E. 33 to E. 7; H. 5 to H. 1	.....	..	..
	.....	....	....	....	..	.....	....	.....	.....	..	..
	.....	....	....	....	..	.....	....	.....	.....	..	..
85	7, 31, 27	1, 8	....	2, 1	1	Eng. 7	No. 3	.....	31, 27	15	4
* Church and Duane St.	29, 12, 6, 4	10	L	5	..	" 29	" 2	.....	12, 10	6	6
	9, 13, 55, 32, 30	20	....	3	..	" 9	" 6	E. 33 to E. 7; H. 5 to H. 1	.....	..	..
	.....	....	....	....	..	.....	...	.....	.....	..	..
	.....	....	....	....	..	.....	....	.....	....	..	..
86	31, 7, 12	1, 8	....	2, 1	1	Eng. 31	No. 2	.....	31, 12	3	6
* Broadway and Thomas St.	27, 29, 9, 55, 4	10	L	3	..	" 27	" 3	.....	27, 33	6	7
	6, 32, 13, 20, 33, 30	20	....	5	..	" 6	" 6	E. 13 to E. 7; H. 5 to H. 1	.....	..	..
	24, 17, 15, 10, 11, 25	9	....	4	..	.....	....	E. 18 to E. 55; H. 18 to H. 20	.....	..	..
	18, 28, 5, 14, 3	5	....	....	..	.....	....	E. 5 to E. 17; E. 16 to E. 14	.....	..	..
87	7, 31, 12	1, 10	....	2, 1	1	Eng. 7	No. 2	.....	31, 12	20	4
* Duane and Elm St.	27, 9, 55, 29	8	L	3	..	" 27	" 3	.....	27, 10	15	6
	4, 32, 6, 20, 13	6	....	5	..	" 4	" 5	E. 33 to E. 7; H. 5 to H. 1	.....	..	..
	.....	....	....	....	..	.....	....	.....	.....	..	..
	.....	....	....	....	..	.....	....	.....	.....	..	..
88	7, 31, 12	1, 8	....	2, 1	1	Eng. 7	No. 2	.....	31, 12	20	4
* Centre near Pearl St.	9, 27, 55, 29	10	L	3	..	" 9	" 3	.....	27, 13	15	6
	4, 32, 20, 6, 17	6	....	5	..	" 4	" 5	E. 33 to E. 7; H. 5 to H. 1	.....	..	..
	.....	....	....	....	..	.....	....	.....	.....	..	..
	.....	....	....	....	..	.....	....	.....	.....	..	..

TABLE ILLUSTRATING ASSIGNMENT OF COMPANIES, AND THEIR MOVEMENT ON FIRST AND LATER ALARMS.

The water is supplied by the reservoir system. Large conduits are run through the main avenues, and from these points distributed to the smaller mains throughout the city. To these smaller mains are connected the fire hydrants which supply the engines with water. The hydrants are of several patterns. Those that are now being set for use are of an improved type, and very seldom freeze, being connected to a sewer which permits the superfluous water from the barrel to pass into the sewer after the valve is closed from the main. Those of the old pattern freeze every winter, so that the engineers, on arriving with their engines, have to open the hydrant to see if it is frozen. If it is, the engineer immediately applies the thaw hose, connected to the boiler of the engine, and uses the steam and hot water from the boiler to thaw out the hydrant, which usually takes about five minutes. When the water is found, the connection is made, and the engine is ready to force water through the hose stretched from the engines to the fire. Many of the streets are still using the six-inch mains, which give a sufficient supply for an ordinary fire, but, when more than the usual number of companies are drawing water from this main, it is entirely inadequate. Many streets are supplied with mains from 12 to 48 inches in diameter, which obviate in a measure the defects of the smaller mains. In the districts where the larger pipes are located there is never a scarcity of water. Since the introduction of the new aqueduct, the supply has met every requirement, even at extraordinary fires.

Spare engines, with men, are detailed to thaw out all hydrants found frozen, and these hydrants are then salted, turning any water remaining in the barrel into a strong brine. This course is followed during each cold spell throughout the winter.

THE RELATION OF FORESTATION TO WATER-SUPPLY.

By Herbert M. Wilson.

ONE of the most striking and significant developments of recent years is the rapidly-increasing interest in meteorology and the growing appreciation of its important relations to a wide range of engineering work.

It is, of course, the study of rainfall and its distribution which is of the greatest evident and practical value. Upon this depend most of the problems of procurement and conservation of water-supply, with their wide range of relations to civil, municipal, domestic, and sanitary engineering. Equally intimate is the dependence of irrigation, the revivified science which many engineers consider the most progressively active branch of the profession at present, and irrigation is already exerting an influence in many departments of industry, of which transportation will not be the least. The whole problem of the flow of streams, and their control in the interests of commerce, manufacture, and the safety of the population resident on their banks, are based upon an accurate knowledge of rainfall over the catchment basin and the influence of topography and vegetation upon the precipitation and run-off.

When many of the largest cities are confronting the question of an enlargement or replacement of their water-supply; when semi-arid western America is looking to the engineer to bring water in the midst of the desert; when the river-cities of the United States are menaced by sudden flood; when the present enormous traffic of the great lakes, and the future greater traffic, are studying the problem of adequate waterways through the lakes and to the sea; when, lastly, the decadent importance of the water-powers of every land has been startlingly electrified to new and abounding life,—it becomes manifest that the study of our "water-revenue" and its maintenance has assumed importance for engineers in all divisions of the profession.

It is my purpose in this paper to discuss the general relations of forests to sources of water-supply. Three phases may be considered:

1. The effect of forests on the ultimate source of water-supply—precipitation.

2. The effect of forest-cover on the water-supply of springs and perennial streams by aiding or retarding percolation.

3. The effect of forest-cover on the intermittent or torrential flow of streams by retarding the rate of surface run-off.

Viewed from a purely sentimental standpoint, the first inclination of one who considers the relation of forests to rainfall is to believe that the cooling shade of forests and the greater amount of moisture in the soil beneath them and in the streams which run through them is due to a greater rainfall in the neighborhood. Few consider that the existence of forests, which require much water for their maturing, is probably due to the natural moisture of the localities in which they are found, as in arid countries their absence is due to the lack of sufficient water to sustain them. Dr. Brandis, of the meteorologic bureau of India, states that the heaviest known rainfall—that in Assam—occurs over one of the densest known forests, and adds: "But it is more probable that the forest exists because of the rainfall than *vice versa*." There is a mass of literature which attempts to prove that this moist condition is produced by the forests, little of which is founded on anything more definite than bare assertions. There are on record no actual tabulated statistics showing the effects of forests on rainfall that can be made to sustain this theory.

All the experiments made in relation to this subject may be divided into two classes, which may be characterized as the retail and the wholesale methods. The retail method has been practised chiefly in Germany, its operations covering limited areas, consisting chiefly in the establishment of two meteorologic stations, one within the edge of the forest and the other at a fraction of a mile from the first and in the open. A careful study of the data shows that the amount of rainfall in the forest is so slightly in excess of that in the open as to be of little economic importance, and no greater than might be due to accidental differences in topography or climate. One must, however, use the greatest care in drawing conclusions from this class of observations, for, as shown by Prof. Cleveland Abbe, the influence of wind on the catch of rain gages is sufficiently great to materially affect the results of such observations. He shows that high gages in forests should catch more rain than low gages in the open because of these effects, and sums up by stating that "the results of certain observations made by Blanford in India serve to dissipate the last argument in favor of the idea that forests appreciably increase the rainfall as distinguished from the catch of the rain gage."

Mr. Henry Blanford, in a report of the meteorological bureau of India, publishes a short series of observations of rainfall at a couple of pairs of stations on the margin of forests in Dehra Dun and Ajmere, India, in 1884-5. Two pairs of stations were established in each place. Rain gages were placed a few hundred yards from the edge of the forest in the open country and at a like distance within the forest. The distance between the stations was about half a mile. Sum-

marized, the observations show that in 1884 the average rainfall at the outer station was 69.97, and at the inner station 70.68 inches. In 1885 the average rainfall at the outer station was 84.57, and at the inner station 86.13. These observations show a very slight excess of rainfall at the inner station,—not quite one inch in 1884 and a little more than one and one-half inches in 1885. The distance between these stations was so slight that it seems scarcely possible to believe that the difference in rainfall was the result of any permanent or general effect which the forest may have had on the climate. It is not unlikely that the differences shown by these observations are due to wind currents about the rain gage in the forest. Much greater differences have been recorded at the same point by two rain gages so placed that one or the other was peculiarly affected by wind currents, or by the distance of the mouth of the gage from the surface of the ground.

Dr. A. Woeikoff made rainfall observations at three stations in the neighborhood of Nancy. Station *A* was within the forest; *B* on the edge of the forest, and 430 feet lower than either of the others; *C* within the open fields, a short distance beyond station *B*, and at the same elevation as station *A*. The total rainfall shown by seven years' observations is 76.7 centimeters at station *A*, 69.3 centimeters at *B*, and 64.9 centimeters at *C*. Here is shown a moderate increase in rainfall in the forest.

It will probably never be possible to conduct an extended series of rainfall observations within a large forest area and within a large area of open land near it which will show definitely the effect, if any, of forests on precipitation. The variations known to exist in the amount of precipitation between two stations not very distant which are placed under identical topographical conditions, and both within forests or both without forests, are quite as great as any which we are as yet able to show between two stations placed one in the forest and the other out of the forest.

The wholesale method of studying the relation of forests to rainfall consists in a comparison of rainfall data obtained before and after deforestation or reforestation has taken place over great areas of country. Such comparisons have been made in many countries, as France, India, New South Wales, and the United States. Another form of the wholesale method is that of the comparison of the climates of two adjacent regions, one forest-covered, the other barren. It is unnecessary to discuss this method, since a description of it is sufficient to condemn it. It is absurd to compare two separate regions with a view to determining forest influences upon them, when naturally their climates may differ greatly with or without forest-cover.

Continued observations of rainfall in the western United States, conducted over portions of the treeless plains in the early days of settlement and since tree-planting has become common, show no appreciable difference in rainfall. It is well known that the cultivable area has moved steadily westward, but this is not a result of increased precipitation, but of better methods of husbanding the moisture of the soil through sheltering it from the dry winds by means of windbreaks and through making it more retentive of what moisture falls on it by ploughing and by more intelligent methods of cultivation.

In the eastern portion of the United States some attempts have been made to determine the effect of forest destruction on rainfall. Mr. Thomas P. Roberts, an eminent civil engineer, made a report of official rain-gage observations at thirty-seven stations for the decade 1870-80. Considering them by halves, the second half shows an increase of 1.68 per cent. of rainfall per annum over the first, though deforestation had been constantly increasing during that period. In all of the Michigan and Wisconsin stations more rainfall was reported in the last half of the decade. In like manner he combined the rain-gage records at Pittsburg, Pa., and Cannonsburg, a town near Pittsburg, for a period of thirty-nine years, and divided these observations into two nearly equal periods, the second half of which shows an average increase over the first of 2.67 inches per annum. Likewise, the increase of rainfall at the city of Philadelphia between 1810 and 1875 has been almost uniformly progressive from 32.67 to 43.35 inches. The above figures appear to indicate an increase in the rainfall with the settlement of the country. These and similar data covering extensive regions in the eastern United States which have been deforested within the past forty years indicate an increase rather than a decrease in rainfall during that period. This may possibly be due to settlement, but records made by gages twenty or fifty years ago must be used with caution, as modern gages are better made and placed, and give larger measures than the old ones.

The most positive evidence that has been gathered to show the effect of forests on precipitation is the result of a study of rainfall observations made by Mr. Blanford in the central provinces of India. It appears that a method of cultivation had been employed there by the wild tribes, which consisted in burning off a bit of forest land and cultivating it for a year or two. At the end of that time the native would move to other localities and burn off a new clearing, only to abandon it again after a year or two of cultivation. The government concluded as a result that deforestation was taking place at too rapid a rate, and accordingly instituted a system of forest protection. During the next ten years forest growth was encouraged over much of

this area, and rainfall observations were conducted simultaneously. Comparisons of observations made for ten years prior to the inception of forest protection, from 1867 to 1875, and for ten years succeeding forest protection, from 1876 to 1885, show an average uniform increase in rainfall in fourteen provinces examined of 6.8 inches. Mr. Blanford says, however, that the error of rainfall observations in the central provinces is five per cent. plus or minus, and that this error might readily account for the differences shown. A study of the progressive increase, if such exist, would tend to show whether the errors in observations were the cause of the total increase of 6.8 inches. An examination of the yearly rainfall statistics proves that there was a progressive increase from 1876, the time of beginning forest protection, and that this increase was about proportional to the tenth of 6.8 inches. The average annual rainfall increased almost uniformly from 49.50 in 1876 to 58.57 in 1883,—an increase of about 20 per cent.,—while the progressive average of rainfall for the rest of the central provinces increased scarcely at all,—from about 40.5 in 1876 to 43.1 in 1883, this increase being due to the general increased rainfall of the latter year evident all over India. It would be difficult to deny the very positive evidence of forest influence on rainfall shown by these figures, were it not for the fact that, since the publication of these data, it has been asserted by Mr. Blanford and other Indian meteorologists that the observations were erroneous.

A careful study of all the statistics obtainable in Europe or in this country bearing on rainfall and the relations of forests thereto fails to indicate positive evidence of appreciable effect on the amount of precipitation by the destruction of forests. Mr. Henry Blanford perhaps sums up as well as could be all that might be said on this subject in his remark: "The difficulty is to disentangle the combined effects of numbers of causes all favoring increased rainfall or the reverse. This renders it a hopeless task to seek for decisive evidence of the influence of forests on rainfall."

Another remark of Mr. Blanford leads to the second division of our subject. He states that "forests protect the soil, and help to keep up the constant evaporation, thus enhancing the rainfall." Of what value is it to enhance the rainfall, if at the expense of water taken from the soil and transpired through the leaves? Moreover, the forests prevent much of the rain which falls upon them from reaching the ground, thus neutralizing their supposed beneficial influences. The usual claim is that forests diminish the amount of evaporation by reducing the temperature beneath their shade and diminishing the force of the wind.

All vegetation imbibes a certain amount of water, a small part of

which is consumed in building up its body, a much larger portion being returned to the atmosphere by transpiration during the process of growth. Experiments conducted in Austria by F. B. Hoehnel show that during the period of vegetation the following trees transpire, in pounds of water per pound of dry leaves, as follows:

Birch and linden	600 to 700 pounds.
Ash	500 to 600 "
Beech	450 to 500 "
Maple	400 to 450 "
Oak	200 to 300 "
Spruce	50 to 70 "
Fir	30 to 40 "
Black pine	30 to 40 "

The variability of the transpiration from day to day is of wide range. A birch standing in the open and found to have two hundred thousand leaves was calculated to have transpired on hot summer days 700 to 900 pounds of water, while on other days its transpiration was probably not more than 18 to 20 pounds. A fifty-year-old beech transpires at the rate of about 400 pounds of water per pound of dry leaves during vegetation, which would make the total transpiration of the tree 3,944 pounds, or at the rate of about 22 pounds of water per day. If 500 trees stand on one acre, the transpiration per acre amounts to 1,972,000 pounds, while the precipitation during the same period would perhaps be 2,700,000 pounds. It accordingly appears that deciduous trees transpire about as much water per annum as is equivalent to a rainfall of ten inches.

It is generally argued that this water has been given back to the atmosphere in the locality in which it fell, thus enriching the atmospheric moisture. It would be absurd, however, to assume that this moisture, after being returned to the atmosphere, simply hovers as clouds over, and is redeposited again on, the place from which it was evaporated. It is caught up by the winds and carried about, some of it falling on cleared lands and some on forests, so that, carrying this line of argument to its logical conclusion, nearly half as much water again should fall on the cleared land as on the forest, since half of what falls on the forest is evaporated to ultimately find its rest on cleared fields, the area of forest and cleared land being assumed to be equal. The soil evaporation beneath dense forest shade is about 40 to 50 per cent. of the evaporation in the open. The trees transpire an amount equal to ten inches in depth. Assuming the average evaporation of a region to be 36 inches in the open, the evaporation of forest soil would be about half of this, or 18 inches, and the evaporation from the trees 10 inches more; that is, the

evaporation in the open would exceed that in the forest by 8 inches.

Experiments show that forests diminish the amount of precipitation which reaches the soil by preventing its falling to the ground. It is well known that in light showers the foliage of the trees protects the ground beneath from being wetted, and we have all seen the circle of dry soil beneath the shade of trees after a light shower which has perceptibly moistened the ground about. It is well known that the water which is thus intercepted by the leaves is returned to the atmosphere by evaporation. According to Vaillant, the amount of waste by the foliage in the forest of Fontainebleau amounted to nearly 40 per cent. of the fall. Experiments by M. Mathieu showed, however, a somewhat less amount of water intercepted and re-evaporated from the leaves of trees. Careful measurements at Swiss stations for an average of twelve years show the interception in a larch forest to be about 15 per cent. and in a spruce forest 23 per cent., while Prussian observations show for beech growth an interception of 24 per cent. Altogether, a dense growth will, on an average, intercept about 23 per cent. of the precipitation. Returning to our former example, if the precipitation were 40 inches, the forests would intercept about 9 inches, and, as the evaporation was about 8 inches in favor of the forests, the balance indicates that less water remains on the soil in forests than in the open.

There is still to be considered another effect of forest-cover on water of percolation. It is popularly believed that litter, the result of decaying leaves, moss, etc., which covers the soil in forests, performs a conservative function, increasing the flow of springs. Mr. B. E. Fernow says that this idea is entirely erroneous and in contradiction to physical laws. He says: "Water filters through the soil-cover by the law of gravitation, until the spongy mass has become fully saturated. If the supply of water continues, it will filter through to the soil and some of it will be absorbed, but the cover will refuse to convey and will shed much of it superficially, leaving opportunity for the water to reach the soil only where the covering of litter is interrupted. The rain having ceased, evaporation begins, and capillary attraction supplies the cover with its loss on the surface from the soil below." Accepting this as true, it appears that the soil cover in forests tends to diminish rather than increase the amount of water entering the soil. Mr. Fernow sums up by saying: "It is, then, the protection against evaporation alone, due to the greater relative humidity of the forest and the shade, the breaking of the winds, and the protective soil-cover, which makes the forest a conservator of moisture. . . . The total conservative effect of the forest is expressed by the difference between the elements of dissipation and

conservation ; the former comprised in the loss of water by retention, interception, evaporation, and transpiration ; the latter in the protection against evaporation. The balance is known to be in favor of the forest-cover."

The evidence does not show that the balance is in favor of forest-cover. If the only conservative effect of forests is a protection against evaporation, then it will be conceded, from what has already been shown, that the difference of evaporation in and out of forests is less than the increased losses within the forests due to the causes cited.

Let us now look at this subject from the last, and perhaps the most important, point of view,—that of the effect of forest on the run-off or surface-flow. It is probable that soil-cover has an influence on the physical conditions of the soil by increasing filtration, because it tends to preserve the granular, porous structure of the soil beneath the litter, thus affording channels for unimpeded drainage. Unless soil cover has a tendency to retard penetration, the influence of the forest upon absorption would be to diminish surface-flow and to increase subterranean drainage; but the same effect would be produced in some degree by all forms of vegetation and cultivation. The nature of the soil and its cover have an infinitely less effect upon the run-off than have the topography, geology, and atmospheric conditions. There can be no question that, between forest-covered, cultivated, or sodded soil on steep slopes, the relative differences in run-off are so slight as to be practically inappreciable. It is also well known that trifling changes in temperature or in wind-velocity have a far greater effect on evaporation, and the consequent amount of percolation, than has forest-shade. In rough country, such as the Adirondack region or the mountains of Tennessee or West Virginia, or of the far western United States, the slopes of the water-sheds are so steep that, in spite of the forest-cover, a trifling rainfall will induce a rapid rise of the streams, though the same amount of precipitation would scarcely wet the ground in more level country. The effect of these factors on run-off is so great, relative to any possible conservative effect which forests may have, as to render the latter scarcely worthy of consideration in this connection. As an instance of the great effect of temperature and wind upon water conservancy, we all know of the enormous and rapid floods produced by a warm rain or wind on snow-covered ground.

Careful observations were made on the river Seine in France by M. Belgrand on two forest areas of equal size, one of which was half cleared, but the observations showed no perceptible difference in their discharges. M. Lemoine, who has been investigating this subject for years in France, says: "The action of forests along the Seine had

no influence upon the flow of streams as compared with the action of ground covered with grass." He says that the only absolutely certain influence of forests on water flow is that it prevents the soil from being carried away by water; in some portions of the Hautes Alpes forests have been replanted with a view to retarding the formation of torrents, or extinguishing torrents already formed, but, he adds, "in most cases turfing alone has produced the same effect." Mr. Russell, as a result of careful observations, says: "Bushes or forests protect the soil from being scored by ravines, but do not seem to affect the regimen of streams, excepting where the soil is left barren."

Numerous statements emanating from mill-owners or farmers have been published, and are used as an argument in favor of the protection which forest-cover affords against floods. These are all to the general effect that certain mills in years gone by received a water-supply, but that in recent years, since timber has been cut above them, these mills have not been running. None of these statements are well authenticated, and there is little to show that the streams which supplied these mills were not as erratic before as after the removal of the forest growth. It can not be denied that such effects appear to have followed the wholesale and wanton destruction of forests. There is no proof, however, that deforestation has any appreciable effect on rainfall, while the old regimen of the streams is practically restored after the cultivation of the deforested area, or after brush or second-growth timber appears. In many of the mountains of the arid western United States, where great forest areas have been burned over, it not infrequently happens that floods wash the soil away before a new growth appears. Then it takes many years, owing to the infrequency of rain, to secure a new growth of trees or brush.

Some years ago Mr. Gustav Wex, an Austrian engineer, published a pamphlet discussing the relations of forests to the flow of European rivers, and attempted to show that deforestation had been unfavorable and reforestation favorable to stream-flow. Mr. T. P. Roberts discussed Mr. Wex's pamphlet in a paper before the American Forestry Association in 1885, and showed, by a proper use of Mr. Wex's data, that it is entirely inconclusive. Discussing American rivers, particularly those at the head of the Ohio and Monongahela rivers, Mr. Roberts shows that conservation of rainfall in local districts is not aided by forests. He also showed that, while deforestation had been going on for some years on the basins of certain American rivers, no appreciable change in their regimen or annual flow had resulted. In fact, as a result of his observations, and those of Mr. Abbott, in New South Wales, and of others, it would appear that, if deforestation had any effect on the run-off of large streams, it was rather to make their

regimen more regular than otherwise. For it is improbable that it would be conducted uniformly over the entire catchment basin of a great stream, and the removal of forests from certain branches only would have the effect, if it left the soil bare, of allowing the water from these branches to reach the main stream a little ahead of the time at which the water from forest-clad branches would reach it, and thus would have a tendency to equalize its flow by extending it over a longer period of time. Stream gagings made in the United States by officers of the United States engineer corps, the United States geological survey, and others, do not show any effect on the flow of the streams by the cutting of forests. The regimen of streams varies so greatly from natural causes, and the curves of discharge vary so greatly for periods of years, or months, or even days, as to obliterate any possible effect which the removal or replacement of forests might have.

The facts here brought together do not depend for their authenticity on the haphazard opinions of those who "think" the regimen of streams is changing in deforested regions,—opinions founded on the recollections of individuals as to the apparent discharges of streams during their childhood. We all know how much credence to give the "oldest inhabitant's" opinion that the "seasons are changing," or that "there never was so early or so late a frost." On the contrary, the materials on which this article are founded are careful investigations and experiments by trained scientific experts.

Authentic and recorded observations cannot be made to show that deforestation has had any effect of economic importance upon the run-off of flood waters, the regimen of streams, or the flow of springs. To sum up further, the same causes have likewise produced no effect of economic importance upon the amount of precipitation. Deforestation, except on very steep mountain slopes, rarely leaves the soil barren. It is usually followed by cultivation or the springing up of brush or other wood growth, and experiments show that all forms of soil cover have nearly as great an average retarding effect on run-off, and as much influence on percolation, as has forest-cover.

Finally, while there is no positive evidence that forests have a beneficial influence on precipitation, or any greater effect on the flow of springs or the rate of run-off than other forms of vegetation, there remains a slight chance that it may influence the last two processes. Accordingly, while there consequently appears no good reason, so far as water-supply is concerned, for refraining from the cutting of woods over regions thereafter to be devoted to agriculture, there is a slight reason for preserving forest-covers on such mountain slopes as are too steep for after cultivation, lest they be washed bare of soil and their influence on run-off and spring supplies be seriously affected.

THE HOT-WATER SYSTEM FOR THE HEATING OF BUILDINGS.

By J. J. Blackmore.

THE subject of this article is far more important than the average architect and builder has been willing to admit in his provisions for the comfort of the occupants of the modern residence, though the writer has observed in some instances a full appreciation of the advantages of hot-water heating.

Before examining the appliances used and the different methods of construction, I will describe the apparatus and its points of advantage, taking for illustration a complete plant arranged for a small house heated by direct radiation, according to the two-pipe system (see Fig. 1).

The heater, being the heart of the plant, is placed in some convenient position in the cellar of the house, and feed-pipes are run from the top of the heater to the radiators in the rooms. Each radiator has also a return-pipe, which is carried back to and connected at the bottom of the heater.

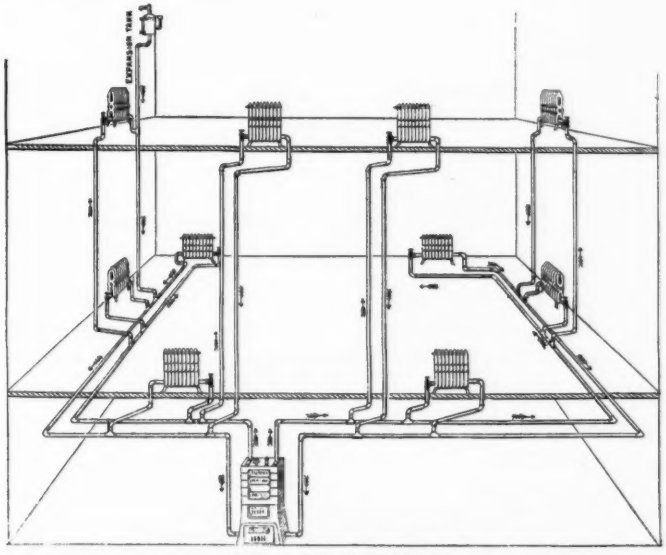


FIG. 1. TWO-PIPE SYSTEM.

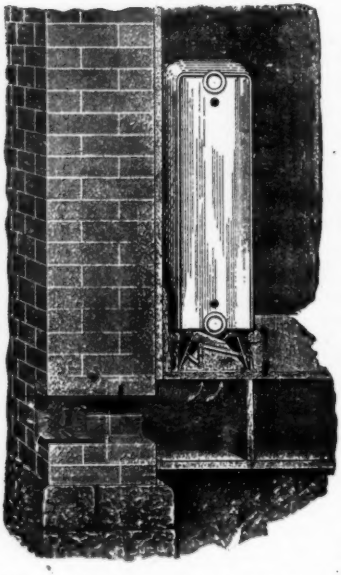


FIG. 2. SEMI-DIRECT SYSTEM, OPEN RADIATOR.

A tank is placed in a convenient position above the highest radiator, and the bottom of this tank is connected to the return pipe of one of the radiators, or to the bottom of the heater, as may be most convenient. From the top of this tank a relief-pipe is taken to the roof, or to some other place where the water can escape, should the apparatus, at any time, become overheated.

Semi-direct radiation differs from direct only in the introduction of fresh air, through the radiator, from the outside, as shown in Fig. 2. The radiator, in this case, has a closed base, and a damper to regulate the flow of air. This method is adopted to supply fresh air for ventilation, and is used largely in schools, hospitals, etc.

Where radiators in rooms are objectionable, or where a large volume of fresh air is needed, the indirect method of heating must be resorted to; in such cases the radiator is hung to the ceiling of the cellar, immediately below the room to be heated, and is enclosed in a chamber of tin-lined wood or galvanized iron. This chamber must be made to fit tightly to the radiator at the sides and ends, but a large space must be left at the bottom to receive the cold air, and a similar space at the top from which to distribute the warm air.

For this purpose special radiators are made in many forms, all, however, using the same method of circulating the air. The fresh air is taken from the outside into the lower chamber, and is passed through the spaces between the sections of the radiator to the upper, or warm-air, chamber, from which a pipe, or flue, leads to the register in the room to be heated (see Fig. 3).

When the semi-direct, or indirect, system is used, it is necessary to have some means of removing the foul air from the rooms in order to make way for the fresh air supplied through the register. In private residences this can be accomplished by the ordinary fireplace flue,

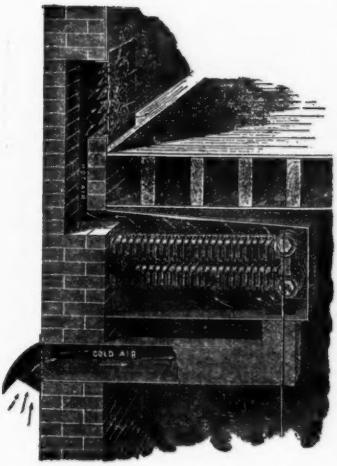


FIG. 3. INDIRECT SYSTEM, CONCEALED RADIATOR.

but in large buildings regular ventilating flues should be provided.

When the apparatus is connected and ready to be filled, water is let into the system till it reaches the gage glass in the expansion tank. The operation is aided by letting the air escape from the air valve in the top of each radiator. When the apparatus shows about four inches in the glass of the tank, the water should be shut off. Then the apparatus is ready for use.

As soon as a fire is started in the heater, the circulation in the pipes and radiators begins, the warm water from the heater rising, and the cooler water in the radiators falling back, according to the laws of gravitation. The extra bulk of the water caused by the heat is held in the expansion tank.

One of the great advantages of this system is the wide range of temperature for which it can be adjusted. The temperature of the water may be as low as 100 degrees or as high as 210 degrees without waste.

In the climate of the northern United States it is necessary to provide for temperatures ranging from 60 degrees above zero to 40 degrees below. Therefore a system which will provide a range of temperature greater than that required by such a climate must be a very suitable medium for distributing artificial heat for personal comfort.

To illustrate this point more fully, I will assume that the apparatus is designed to meet the extreme condition mentioned,—*i.e.*, 40 degrees below zero,—and that the radiators are large enough to give all the heat necessary with the water at 210 degrees in the apparatus. Having these conditions in mind, it will be seen that, if the weather moderates to 20 degrees below zero, the water will need to be heated only to 190 degrees to give the required heat in the house; at zero 170 degrees will be sufficient, and at the freezing-point of water 150 degrees in the apparatus will warm the house to 70 degrees. The only adjustment needed is in the firing.

On the heater should be placed a thermometer to indicate the

temperature of the water in the apparatus. An altitude gage is also useful to indicate at the heater the height of water in the tank.

Thermostatic regulators can now be purchased, which materially add to the ease of management of such an apparatus. They can be arranged to close the draft dampers on the heater, if the temperature rises above 70 degrees in the rooms, and to open them if the thermometer falls below 70 degrees, thus keeping the house at a uniform temperature so long as the fire has attention. A well-designed appatus should not need attention oftener than four times a day in severe weather, and twice a day in ordinary winter weather.

In these days of severe competition, there are plenty of manufactured goods to choose from, and hot-water heaters are no exception to the rule; they are made in almost every form into which cast iron, wrought iron, or steel can be moulded or bent.

One important feature much overlooked by manufacturers in the construction of heaters is the low temperature of the water passing through them, and the difficulty of combustion under such conditions. In many heaters now in use the fire-box is so hedged and covered by comparatively cool surfaces that there is not sufficient room for proper combustion to take place, and a large portion of the fuel, in the form of unconsumed gases, goes up the chimney with the smoke.

Another defect is the excessive amount of grate surface in many heaters, compared with the amount of heat-absorbing surface that is placed above the fire. Very few makers of heaters state the quantity of fire surface in their heaters; most of them are content with stating the size of the grate and the quantity of radiating surface which the heater is capable of taking care of. This rating varies so much that it is very misleading, and the resultant mistakes have often been the cause of a failure, or partial failure, to give the good results which would have been secured if the full details of measurement or a more conservative rating had been given.

A good proportion of grate surface to heating surface for a hot-water heater is one foot of grate to eighteen feet of fire surface, in small heaters, and one to twenty-five in larger sizes. The proportion of fire surface in the heater to the radiating surface in the system should be one to eight, or one to ten, for the smaller sizes, and, for the larger sizes, one to twelve, or one to thirteen. These proportions may be changed by a more rapid rate of combustion, but this means closer attention to the fires and greater consumption of fuel.

The best forms of heaters are those of the water-tube type, the fuel gases being cooled much more quickly in the fire tube, on account of being separated and surrounded by cool surfaces, while in the water-tube type the water is separated and the gases kept together,

allowing a much better combustion of the gases. Some water-heaters are so peculiarly constructed that it is difficult to state in which class they belong, but the above remarks will enable the reader to more readily appreciate the merits of any heater he may choose to examine.

Two features of great importance must be kept in mind. Heaters must be arranged so that the fuel can be thoroughly burned, and the surfaces must be presented to the fire so as best to absorb the heat from the fuel.

It does not make any material difference how the heater is put together or what is its shape, so long as its construction is durable and properly arranged for cleaning and for the circulation of the water.

Many engineers and some manufacturers contend that the vertical section is preferable to the horizontal, but this depends a good deal on the shape of the section. My experience slightly favors the horizontal type, for the reason that the friction offered by this form is of benefit to the water circulating through it. The friction, however, in many heaters of this class, is so great as to offset any advantage the form may otherwise possess. Too much friction in a heater retards the circulation, and allows steam to form, causing trouble and injury to the working of the apparatus. On the other hand, the reason why a certain amount of friction is advantageous is that the water, in circulating through the system, gathers an impetus, due to its weight, similar to the momentum accumulated by the fly-wheel of an engine as its revolutions are increased. This impetus is sufficient to carry a certain portion of water through the heater without taking up heat, unless some friction is offered to divert the water over the hotter portions of the fire. If this is done carefully, the heater can be kept, in all its parts, at a uniform temperature, and very little wear is occasioned by expansion. If the friction is unduly increased, the circulation of the water is retarded, and steam is generated; this allows parts of the heater to become overheated, and, in cast-iron heaters, will often cause the

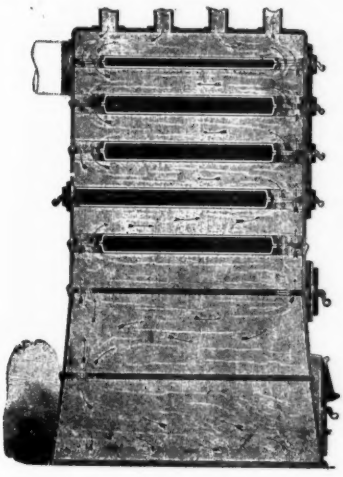


FIG. 4. HEATER WITH POSITIVE CIRCULATION.

section to crack, or at least will cause a very annoying water-hammer.

In Fig. 4 is shown a section of a heater with a positive circulation, and yet of such a form that but little friction is offered to the movement of the water. In Fig. 5 is shown a section of a common form of heater, which offers too much resistance to the flow of the water through it; in all such heaters steam is very apt to form before the water can get through, especially if a strong fire is kept in the heater. Fig. 6 also shows a common form of heater without any provision for circulation; an examination of this will show at once that, if there is any impetus to the water when it enters the bottom of the heater, it will pass through the easiest passage, which is at the outside of the section and away from the fire. Some engineers contend that no impetus is gathered by the water in circulation, but this assumption is easily disproved by a little calculation. Let us take as an illustration a radiator containing one hundred feet of surface. Let us assume that each foot of this radiator gives off 175 units of heat for each square foot of surface per hour, or a total of 17,500 units per hour, and that the difference in temperature between the flow and return pipes is ten degrees,—equal to the passage of 1,750 pounds of water to and from the radiator per hour. As radiators of this size are usually fed by a 1¼-inch pipe, this means a velocity of about fifty-five feet per minute. As an ordinary apparatus contains from one and a half to two tons of water moving at a velocity of fifty-five feet per minute, the force gathered is considerable.

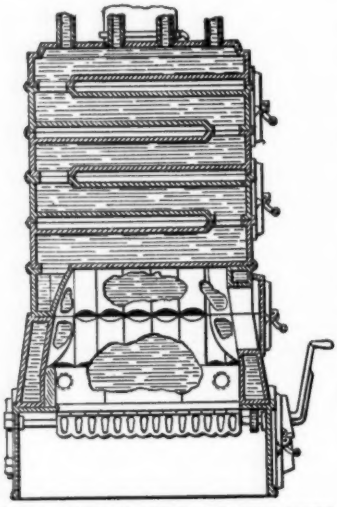


FIG. 5. HEATER WITH RETARDED CIRCULATION.

The success of a hot-water heating apparatus will depend very largely on the skill with which the flow and return pipes are put in place. Three requirements are essential to success. The pipes must be properly proportioned and properly graded, and must be put up with as few sharp bends as possible.

In proportioning the flow and return pipes, the laws of hydraulics must be carefully considered, especially in relation

to friction on the water flowing through the pipes. The friction is much greater on the small pipes than on the larger sizes.

Various rules have been suggested for proportioning the size of main flow and return pipes, but none of them are entirely satisfactory to me. Those based on the velocity of water due to the height of a column are misleading, because of the great variation in the heights of buildings.

I have devised a rule by taking into consideration the average head, the friction, and the velocity of flow necessary to supply the lost heat.

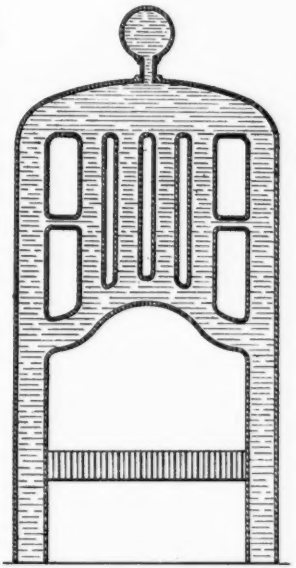


FIG 6. HEATER WITH UNCHECKED CIRCULATION.

I take as a basis for calculation a radiator containing 100 feet of surface. Such a radiator loses about 175 units of heat per square foot per hour, when working at a temperature of 185 degrees, and, assuming that to be the required amount, this is equal to 17,500 units per hour. As the water, in circulating, will lose ten degrees, this means 1,750 pounds of water per hour, which, if fed through a 1½-inch pipe, attains a velocity of about thirty-five feet per minute, or, if fed through a 1¼-inch pipe, attains a velocity of fifty-five feet per minute, and, if fed through a 1-inch pipe, a velocity of eighty-five feet per minute. The 1½-inch pipe requires a head nearly four feet high, the 1¼-inch pipe a head of nine feet, and the 1-inch pipe a head of nineteen feet.

On the ground-floor of a building it is always possible to get a head of four feet, but not always a head of nine feet. It seems from this that the ratio of the area in a main for 100 feet of surface in a horizontal pipe is the area of a 1½-inch pipe. We should add to this something for friction, which, on one hundred feet of pipe and a number of elbows, will be considerable. If we increase the area one-fifth on this account, we have 2.13 inches of area as necessary to supply one hundred feet of surface under ordinary conditions. Probably a more exact figure is 2.10, which is what we get if we divide the diameter of the pipe into the ratio of its circumference. Now, as the ratio of the circumference to the diameter represents also the

ratio of the friction on its contents, this ratio may be used as a constant, and we get the following simple rule for the area in inches required in a pipe for each one hundred feet of surface in a heating plant:

$$r = \frac{3.1416}{d}$$

in which r is the ratio and d the diameter of the pipe. From this formula we make up the following table:

Size of Pipe.	Ratio per 100 Feet of Surface.	Area of Pipe.	Quantity of Surface this size will supply.
1½″	2.10	1.767	84
2″	1.57	3.141	200
2½	1.25	4.908	400
3″	1.04	7.068	700
3½	.90	9.621	1062
4″	.78	12.566	1590
4½	.70	15.904	2272
5″	.63	19.635	3120
6″	.52	28.274	5440
7″	.45	38.484	8550

If the pipes are extended beyond one hundred feet, the friction will be fully provided for, if we use the ratio for one size smaller for each one hundred feet that the mains are extended. Thus, if a main is 200 feet long, use the ratio for a 4-inch pipe in place of the 4½-inch, and for 300 feet use the ratio for 3½ in place of 4½, and so on. The foregoing table is for horizontal main and distributing branches, and is not to be applied to rising pipes.

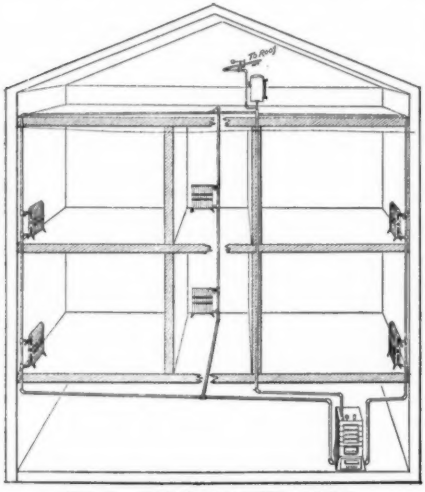


FIG. 7. SINGLE-PIPE RISER SYSTEM.

We have shown that the hot water necessary to supply one hundred feet of surface can be sent through a 1¼-inch pipe with a head of nine

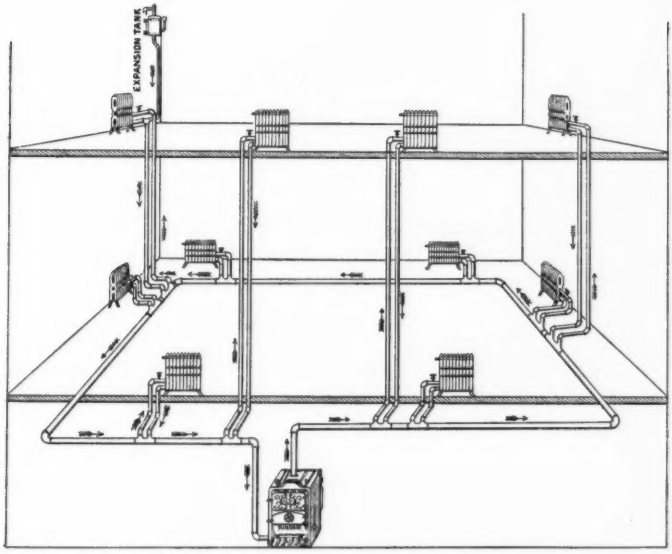


FIG. 8. SINGLE MAIN-PIPE SYSTEM.

feet, and through a 1-inch pipe with a head of nineteen feet. This shows clearly that we can supply such a radiator on the second floor with a 1¼-inch pipe, and on the third floor with a 1-inch pipe; the higher the building, the more the radiation that can be supplied with a given size of pipe.

Fig. 1 illustrates the two-pipe system. Fig. 7 shows a top-feed single-pipe riser system which is very largely used, and gives very satisfactory results. It is almost always resorted to in houses or other buildings having only low cellars or no cellars at all. It is also resorted to for heating radiators placed on the same floor or level on which the heater is placed.

Figure 8 shows the "single main-pipe" system, and is coming rapidly into use, being more neat in appearance and more durable, as well as losing less by friction and radiation than any of the other methods.

The rising pipes are the same as in the regular two-pipe system, the feed pipe being taken from the top of the pipe and the return back into the side; or, by a patent fitting now on the market, both pipes may be taken off the top, as the return opening in the fitting is passed to the under side by a shield.

It cannot be said that anyone of these systems is the best for all buildings, but it is easy for the engineer to determine which is the best for the case in hand.

Radiators are now made in so many different forms that it is impossible to consider them in detail, but we will deal with the different types, and endeavor to explain their relative merits.

A single-loop radiator, or a pipe coil, is more effective per square foot of surface than is a two-loop radiator. The two-loop is more

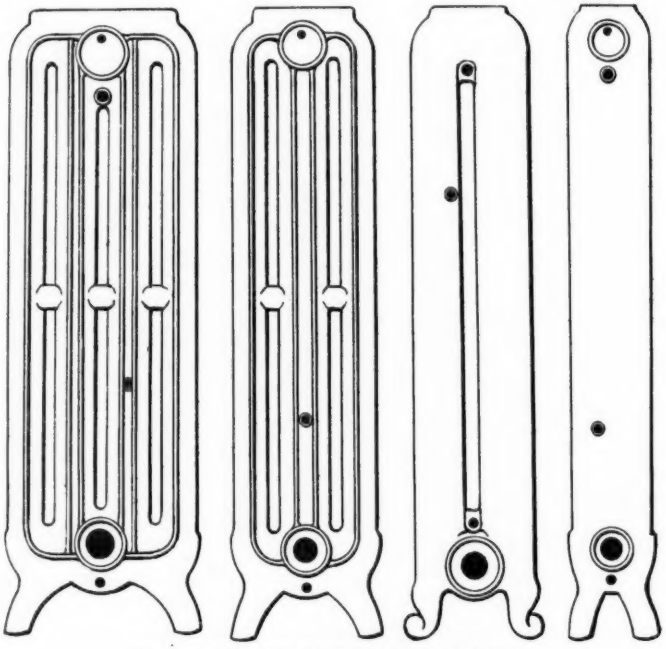


FIG. 9. SINGLE- AND MULTIPLE-LOOP RADIATORS.

efficient than a three-loop, and a three-loop is better than a four-loop.

The single loop, or coil, is the best form, for the reason that the radiation is not obstructed by other portions of its own surface, and the air has a free circulation around and through it; moreover, its surfaces can radiate heat more freely than a two or three-loop. For the same reasons the two-loop is better than a three-loop, and so on. The more open and exposed a radiator is, the more readily will it give off heat to the air and to the cooler objects in the room (see Fig. 9).

The height of a radiator is also a factor that has an influence on its efficiency ; a low radiator will give off more heat to the air per foot of surface than a high one, for the reason that, the nearer the floor the surface is, the more heat will it give off to the air by contact. The property of radiation, however, is not affected by its height.

My experience leads me to think that the relative efficiency of the different types per foot of surface diminishes about five per cent. for each loop added. If we take that of the single loop as 100, that of the two-loop is 95, that of the three-loop 90, and so on. The relative efficiency of height is not so apparent, and I have not found that less radiating surface can be used with low patterns, for the reason that the low patterns of radiators are almost always bunched together, losing in this way what is theoretically gained by giving up more heat to the air. Low radiators are more expensive than high ones, but they are so necessary under windows, or in other positions where a high one cannot be used, that the extra cost is more than offset by the convenience.

It is well to add here that a hot-water radiator differs from a steam radiator in that it has connections at both top and bottom, while the steam radiator is connected at the bottom only ; this connection being the passage between the sections that go to make up the radiator.

Indirect radiators are also made in various forms and sizes. In the early days of hot-water heating, indirect radiators were made of box coils of iron pipe ; though very efficient, they have been replaced by cast-iron sections, which are much cheaper and do as good work.

FIG. 10. HOT-WATER VALVE.

The cast-iron fin or pin type is generally used, but a few are made of a type called "prime surface," and are very effective. Almost any of the indirect radiators on the market give good results if properly put up and sufficient surface is put in for the work required.

The valves used in hot-water heating differ materially from those generally used in steam work, though, when hot-water heating first became general, the same valves were used as were used for steam.

For controlling the main distributing-pipes, gate valves are always used, because they offer less friction than any other kind. On the radiators what is known as a quick-opening valve is used ; it works like that of an ordinary plug cock, though not made to shut tight (see Fig. 10). The plug is usually made of sheet brass, and turns in a brass shield, one half-turn opening or closing the valve entirely. When the valve is shut off, there is still a leakage through

it, designed to allow enough circulation to prevent freezing in a radiator, should one be shut off in an exposed room. While this leakage is sufficient to keep the water from freezing, the radiator is cold to the touch, if the hand is placed upon it.

The air valves used on a radiator are of a very simple kind, working either with a wood wheel or a loose key. Various attempts have been made to devise an air valve for hot water that will work automatically, but they have not been successful, and as the need for such a valve is not pressing, it is not likely that it will come into general use.

In ordinary residence work valves on the main pipes are not necessary, nor, in fact, are they necessary in any plant, except for convenience in making repairs, for which purpose a large apparatus may be divided into sections with valves to control each one, so that, if any section requires repairing, it may be cut off and drained out. In the same way each set of rising pipes may be valved and cut off without stopping the rest of the apparatus.

The cost of installing a hot-water heating plant in residences, where direct radiation is used, runs from two to three cents per cubic foot of space heated; when indirect radiation is used, it runs from three to five cents per cubic foot, according to the extent to which the indirect system is employed.

This cost is slightly in excess of that of a steam-heating plant, owing to the fact that all radiators and circulating pipes must be of larger capacity. This extra cost, however, should not exceed 15 per cent. of that of a steam-heating plant. The cost of a hot-water plant, as compared with a warm-air furnace, is about 75 per cent. greater; but this is compensated for by more economy in operation. The cost of operating a hot-water plant is about 15 per cent. less than that of a steam plant, and about 30 per cent. less than that of a hot-air plant, assuming the conditions in each case to be equal.

PECULIAR FEATURES OF IRRIGATION ENGINEERING IN COLORADO.

By H. A. Crafts.

AGRICULTURE by the aid of irrigation in the United States has so far exceeded in its achievements the expectations of the most sanguine, and still holds so glowing possibilities for the future, that year by year the value of irrigable lands and of the water by which they may be irrigated is largely enhanced, and the quest of water available for irrigation grows more and more keen. Astute engineering minds are constantly employed in devising schemes for increasing the supply of water, and for husbanding it when secured.

In Colorado, for instance, it is safe to say that to-day every available cubic foot of water flowing towards the Atlantic has been appropriated for irrigation or manufacturing purposes. Whether the facilities for utilizing it all are sufficient is another question, but this problem promises to be solved in a few years by a multiplication of storage reservoirs, which are being constructed in great numbers upon the plains by the companies owning the various systems of irrigating ditches now in operation. And it may here be noted that the plains

NEAR THE HEAD OF GRAND RIVER, COLORADO. TAKEN IN LATE SUMMER.

reservoir has proven far better adapted to the irrigation system than the mountain reservoir, for more than one reason. The mountain reservoir usually is narrow and deep, and requires a large dam which may be carried out during a flood, causing enormous damage and possible loss of life by the release of an immense body of water; whereas the plains reservoir may be large in area and formed by some natural depression in the land, supplemented by earth-diking. In most cases the danger of bursting dams is reduced to a minimum, and, as the reservoir is located near or directly in the midst of the lands to be irrigated, the water may be conveyed from the reservoirs to the farm lands with but little trouble.

But many of these companies find that their facilities for carrying water and for storing the same, and the acres under their ditches that thirst for irrigation, increase far more rapidly than the means for increasing the visible water-supply. The temptation to cover more land is constantly before them. Their ditches may be extended almost without limit, and made to traverse lands that need but the fructifying influence of moisture to make them productive almost beyond belief. So the search for more water goes steadily and eagerly on, and the methods employed have in some instances, apparently at least, reversed the order of nature. To be more explicit, they have scaled the crest of the continent, and propose to turn the waters of the Pacific slope into the watershed of the Atlantic. The point is to seek the head waters of those streams whose available supply has not already been fully appropriated for irrigation purposes, and turn certain portions of that supply backward and across the divide, into a

CONSTRUCTION CAMP, BIG LARAMIE CANAL, COLORADO.

CUTTING THE RIGHT OF WAY THROUGH GREEN TIMBER.

different watershed altogether, and add them to that already utilized in the system of irrigation.

To the uninitiated this might seem to be an impossible feat, yet in substance it has been accomplished, and the scheme is in successful operation. In northern Colorado the waters of the Big Laramie, which flow northward into Wyoming and empty into the North Platte river, have been intercepted high up in the Rocky mountain range, and carried, by means of a transalpine ditch, southward across the Medicine Bow mountains and poured into Chambers lake at the head waters of the Cache la Poudre river, whose waters flow southeastward, emptying into the South Platte river in eastern Colorado. This feat was accomplished by the Water-Supply and Storage Company, owners of the Larimer county ditch, one of the largest irrigating systems in Colorado.

It was an interesting piece of engineering, successfully accomplished, although at a loss of nearly $10,000 by the contractors, among the oldest and most experienced firms in the west. Fifty miles they climbed into the rugged mountain range, to an elevation of 9,500 feet above sea-level, or 5,000 feet higher than the plains at the foot of the range, and dug a ditch five miles in length, along the steep mountain sides, now through heavy timber and now along a crumbling hillside, or perhaps through solid rock.

In the first place, all the men, teams, tools, machinery, and pro-

visions employed on the work had to be transported over fifty miles of rough mountain roads, parts of which were constructed for no other purpose than to reach the scene of this exploit. And, when the contractors finally reached their base of operations, there were the surveyor's stakes indicating the location of the proposed ditch far up a steep mountain side, some fifteen hundred feet above camp. Up this mountain side all the tools, machinery, and camping outfits had to be packed on mules and men, involving a long and tedious task. Then there was the difficulty of establishing grading camps and commencing the work of construction on the steep acclivity. It was like working on the slope of a roof. Yet the task was accomplished, and the men and teams went to work.

CUTTING IN THE DEAD TIMBER, BIG LARAMIE CANAL.

In the first place, the right of way was cleared of timber and vegetable matter. The trees, not being very firmly rooted in the earth, were toppled over and uprooted by means of guys, and the pine cones, spills, etc., stripped off down to the solid earth. Then followed the mule teams with plows and scrapers, unless the work was in solid rock, when the men commenced the work of drilling and blasting. And, though the adhesive powers of the patient mules were considerable, it was no unusual spectacle to see a mule team rolling down the steep hillside to the gulches below, not, however, with fatal results, the only damage sustained being in the shape of cuts and bruises.

So the contractors labored on from August to December, and then, when the snows and frosts put an end to their work, they found they had accomplished but little more than half of their contract, and were

out of pocket $17,000. They returned to the work, however, during the following season, and, by a clever stroke of subcontracting, pulled out in the neighborhood of $8,000 profit, cutting down their net loss on the entire job to $9,000 or $10,000.

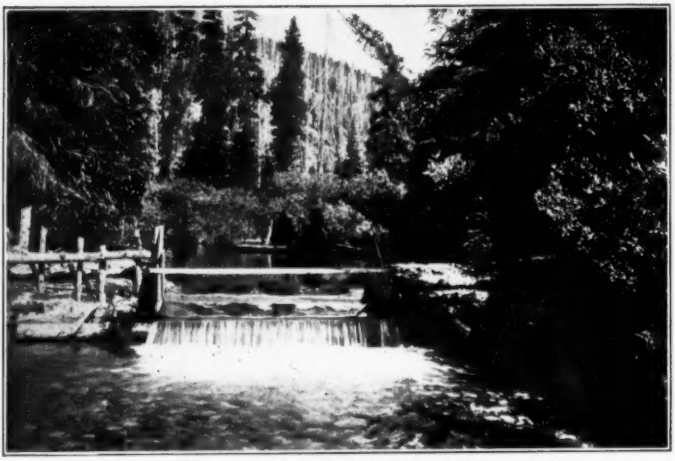
But to the ditch company this feeder has proven of inestimable value. It has made their ditch one of the most reliable in the State. No complaints are heard of a loss of crops on account of a lack of water. The company is not only enabled to run its ditch to its fullest capacity during the irrigating season, but to fill its immense system of storage reservoirs, and also furnish water for the irrigation of late crops. The ditch is maintained and operated at a cost ranging from $1,500 to $2,000 per annum. During the open season it is

ENTRANCE TO TUNNEL ON THE BIG LARAMIE CANAL.

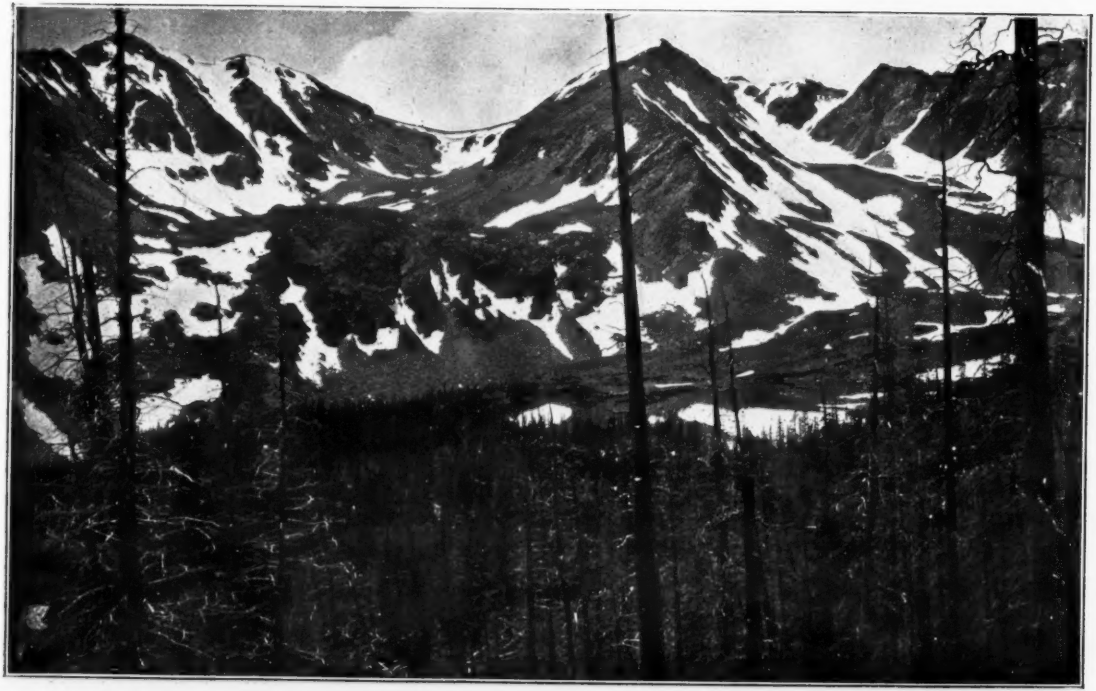
constantly beset by dangers. Rock-slides, land-slides, snow-slides, and cloud-bursts sum up the catastrophes that are liable to occur and carry down yards and yards of the ditch bank, rendering the ditch useless for days together, possibly in the very midst of the irrigating season. Or springs sometimes crop out beneath the lower bank, causing erosions and a final slide of the entire bank. Or the burrow of some animal beneath the bed of the ditch may open a way for the water to start a break, which is equally disastrous. To guard against these untoward happenings, the ditch is patrolled for nine months in the year. About the first of March a crew of twenty men is put to work clearing away snow and all trees or other *débris* that may have fallen in. The trees that stood on the upper bank, by constantly swaying in the wind, loosened the earth in many places, so that it fell

A SECTION OF EARTHWORK ON THE BIG LARAMIE CANAL.

in masses into the ditch. To prevent this, the timber has all been felled along the upper bank for a distance of thirty feet back. Masses of dirt and rock also fell into the ditch from the action of the frost; so those portions likely to be affected by frosts have been excavated, and the earth has been used in strengthening the lower bank. Log-curbing is also used to a large extent for the same purpose. To provide against the danger from the sudden influx of water from a



RATING WEIR NEAR THE HEAD OF GRAND RIVER, COLORADO.



THE SNOWY RANGE IN MIDSUMMER, SHOWING THE SOURCE OF THE LATE SUMMER WATER SUPPLY.

CLEARING THE RIGHT OF WAY, GRAND RIVER CANAL.

cloud-burst, a system of automatic spill-ways has been inaugurated at various points along the ditch. These are arranged so that, when the water rises above a certain point, a gate is lifted, and the surplus water allowed to pass off over a weir, thus relieving the ditch from any extra strain. By the constant cleaning and cutting away of the upper bank, the ditch becomes enlarged, and its carrying capacity increased, so that there is some compensation for the work done, outside of the mere strengthening of the ditch. By June 1 all the clean-

GRAND RIVER SUPPLY CANAL, PARTIALLY CONSTRUCTED.

ing and repairing have been finished, and the crew is cut down to four men, who do principally patrol duty until the end of the season,—December 1. Then the snows begin to fall, and ice to form in the streams. Yet the water in a portion of the ditch is permitted to flow beneath the ice all winter, as it tends to keep the ditch clear of snow and ice.

It may seem paradoxical to speak of conducting water from one water-shed to another. The divide seems an insurmountable barrier. In the first place, it must be understood that the head waters of these mountain streams lie high up in the gulches, and are constantly fed by the many springs that gush from the mountain sides and the melting snows that lie in the gorges. In many cases these sources of water supply lie much higher than the adjacent mountain passes crossing the divide, and the canals are led around the shoulder of the intervening spur and into and through these passes to the opposite watershed.

In the construction of the Big Laramie canal the west branch of the stream was dammed at an altitude of 9,500 feet, at a point on the north side of Clark's Peak, where the stream at high water discharges five hundred cubic feet of water per second. Here the head-gate was located, and the canal carried eastward for a distance, and then curved gradually around the east flank of the Peak, and finally turned in a south-westerly direction and emptied into Chambers lake at the head waters of the Cache la Poudre.

Besides the water taken from the Big Laramie, the canal intercepts and is fed by numerous small streams that flow down the mountain side. In order to carry this augmented water-supply, the canal is gradually increased in size as the outlet into Chambers lake is approached. At present the carrying-capacity of the ditch at its head is about 250 cubic feet of water per second, while at its lower end its capacity is 400 feet per second. It is the intention of the company to gradually enlarge the canal until it can carry all of the water flowing in the west branch of the Big Laramie and all the intervening water-supply as well.

But in this particular case the identical water thus secured cannot be directly diverted to the main ditch of the company. The head gate of the main ditch is fifty miles east of Chambers lake on its outlet stream. So the water discharged by the Big Laramie canal is measured at the point of discharge by the water commissioner, and the ditch company is permitted to take from the river at its main head gate an equal amount of water, less a slight percentage allowed for evaporation upon the fifty-mile journey from Chambers lake to the plains. The use of the natural bed of the stream for the con-

duct of water thus contributed to its volume is authorized by legislative enactment, and, although it was strenuously opposed at the outset, it has so far stood the test of the courts.

A similar piece of work is about to be undertaken by the National Land and Irrigation Company, owners of the North Poudre canal and a vast amount of land in northern Colorado. The North Poudre canal is fifty-two miles in length, and has as an adjunct a system of storage-reservoirs whose aggregate capacity is 812,000,000 cubic feet of water; yet its water-supply is far from adequate to the wants of the company. It has thousands of acres of excellent land that only needs moisture to make it highly productive. So the chief engineer, Mr. A. G. Allan, is busy upon schemes to secure the needed supply. His pet scheme is the construction of a transalpine canal that shall bring water from the head waters of the Grand river (a stream which has its rise in the main range of the Rocky mountains in northern Colorado and flows southwestward, emptying into the Colorado river, which in turn empties into the Pacific ocean) over the continental divide, and deliver it into the head waters of the Cache la Poudre river, which rises on the eastern side of the range and flows down the Atlantic slope.

During three months of the summer and fall of 1897 Mr. Allan, at the head of a crew of men, was engaged upon the preliminary work of this proposed canal. High up, near the summit of the great range, in regions of perpetual snow, he ran surveys, constructed rating weirs, and even commenced the excavation of the canal itself. Mr. Allan, during his stay upon the head of the Grand, took a number of photographs, which have supplied the illustrations accompanying this article. A careful investigation established the feasibility of the scheme, and another year will doubtless see it consummated, when water that has hitherto found its way westward to the Pacific will be turned back upon its course and led eastward across the range, and thence upon the plains of eastern Colorado.

The head waters of the Grand lie in a fan-like shape, enclosed by a continuous range of mountains, many peaks rising 13,000 feet above sea-level. The mountain range is in the shape of a horse-shoe, and faces south. The lowest pass—Mountain Meadow park—is situated at the northeast corner of the horse-shoe, and is low enough to allow a ditch draining the larger portion of the Grand river basin to discharge its waters into the opposite drainage area, or the basin of the Cache la Poudre river.

All of the creeks which feed the Grand river in this neighborhood tend in an easterly and southeasterly course, and are, with two exceptions, on the west side of the Grand. The proposed ditch is on

that side of the river, and will cut off practically all of the water before it reaches the main stream, and discharge it over the pass into the Cache la Poudre. The creeks are situated in a gulch many hundred feet below the surrounding mountains, and, as they run east or west, the north winds blow the snow, above timber-line, into these gulches, until the drifts are fifty feet deep. This is the main source of water-supply for the head waters of the Grand river.

This drainage basin has an area of about seventeen square miles, is densely covered with heavy spruce and pine timber, and has, every winter, a heavy fall of snow. In the winter of 1897, in the woods, where it did not drift, the snow was from five feet six inches to eleven feet deep on a level. This fall was above the average. There is no doubt of the enormous fall of snow in this region. The creeks commence to discharge about April 15, increasing in quantity until the first week in July, after which there is a continual decrease until they freeze.

In the Grand, below the junction of Saw Mill and Camp creeks, Mr. Allan constructed a rating weir; also one in South Lead Mountain creek. He kept a daily record, which shows an average monthly discharge of water which would give to a canal, discharging a maximum of 80 cubic feet per second, sufficient water for more than 4,000 acres of land during the irrigating season.

In regions of this description Mr. Allan favors the building of narrow, deep ditches with steep grades. One of his reasons is that the first cost of construction is much less than that of wide shallow ditches. Another reason is that the cost of repairs rendered necessary by snows and storms is less. In California ditches carrying 80 cubic feet per second have been built, and are in successful operation with grades from sixteen to twenty feet to the mile.

The secret of the large and late run of water in the Grand river is the very low temperature prevailing at that altitude. There were only three nights in July, 1897, and two in August, that the thermometer did not drop to 32 degrees. This low temperature has a direct influence upon the creeks, the highest discharge being about 6 o'clock P. M., and the lowest about 7 o'clock A. M. In case of the weather remaining cool for several days together, the snow melts so much more slowly that the decrease of water-supply is about forty per cent., and thus the flow of water is greatly prolonged.

In the way of construction, the work performed consisted of the clearing of the right of way of all timber and the felling of all trees liable to fall across the ditch from storms or forest fires. The top soil was also removed for a part of the distance. This soil consists of decayed vegetable matter, and will be removed not only from the bed of

the ditch, but from the ground that will underlie the banks in order that the latter may have a solid foundation. The material excavated from the bed of the ditch will all be used to raise the lower bank, which gradually solidifies into a firm mass. In general, the use of flumes is to be avoided, but about 3,000 feet will have to be used on the Grand River canal, 1,700 feet being through hard, porous, and shattered material. For the construction of flumes native spruce can be obtained at $8 per thousand feet. The flumes will be made as nearly water-tight as possible, as leakage would loosen, and perhaps destroy, the foundation. The cost of similar canals in California was from $7,349.20 to $8,485.40 per mile, but the cost of the Grand River canal will be less, on account of the lower rate of wages. There will be a disadvantage of location, distance from railroads, and the difficulty of transportation over mountain roads, many of which will have to be rebuilt, but these are considered minor matters compared with the obstacles which were encountered in the construction of the California canals.

The canal, when completed, will be five miles in length, ten feet wide at the bottom, and from twelve to fifteen feet wide at the top, and will carry water to a depth of three and one-half feet. The canal can be operated after the first year with a force of three men and a superintendent, at a cost of $245 per month, or $1,720 for the season. The annual cost of operating and maintaining large ditches, including in the calculation of annual expenditure all repairs and taxes, is estimated at $400 per mile.

When completed and in operation, the canal will deliver Grand river water into the Little South fork of the Cache la Poudre, and thence the water will flow into the main stream and down to the plains, some fifty miles distant, where it will be delivered pro rata to the various ditches on the main Poudre, in return for which the National Land and Irrigation Company will be allowed to take an equal amount from the north fork of the Poudre for supplying its ditch and reservoirs.

A more reliable and satisfactory source of water supply could hardly be imagined than that afforded by these lofty regions. Besides the heavy rainfall to which they are subject during the summer months, there are inexhaustible deposits of snow and ice in the deep gorges of the upper peaks. These are melted by the summer sun, and keep all the creeks and rivulets running full, the flow of water depending largely upon the amount of sunshine expended upon the snow-banks. These snow-banks act as a reserve, and furnish water long after the snow has melted from the mountain sides and the other sources of water are well-nigh exhausted. This late water becomes

very valuable in the irrigation of late crops which might suffer from drouth if dependent solely on ordinary sources of supply.

The extent to which this method of obtaining an additional water-supply could be developed depends upon the amount of unappropriated water that may be found in neighboring watersheds, and feasible routes for the construction of supply-canals across the intervening divides.

There are undoubtedly large quantities of unappropriated water still flowing down the Pacific slope of the Rocky mountains, but, as agriculture is rapidly coming to the front in that region, it is only a question of time when all of the available water-supply will be appropriated. Yet the ditch companies of the eastern slope are not slow in taking steps to secure all the water possible from that source before the supply shall be exhausted.

SUPREMACY IN THE IRON MARKETS OF THE WORLD.

By J. Stephen Jeans.

IV.—CONDITIONS AFFECTING THE ECONOMICAL MANUFACTURE OF FINISHED PRODUCTS.

IN previous articles we have considered the competitive circumstances of different countries in reference to raw and semi-crude materials. We have now to deal with the conditions under which the same countries produce finished products in the forms of rails, plates, bars, angles, wire rods, and similar commercial commodities. This, it is obvious, is less a question of natural advantages, and more a question of the cost and efficiency of labour, and of the command of economical appliances and processes, than any of the aspects of metallurgical status already dealt with in the present series.

In a letter which he wrote to Horace Mann, more than a hundred and twenty years ago, Horace Walpole declared that he believed that "England will be conquered some day in New England or Bengal," and on another occasion he wrote to the countess of Ossory that "there are many able Englishmen left, but they happen to be on the other side of the Atlantic"—referring to the United States. The first statement appears to have been almost prophetic; the second had some truth, if much exaggeration. If we take New England as typical not only of the eastern States, but of the middle and southern States as well, Walpole's prediction is within measurable distance of fulfilment; at any rate, British supremacy is being challenged. I do not thereby imply that the British are to be vanquished, because they are scarcely made that way. By and by, no doubt, it will resolve itself into a tug of war, to which Wellington's remark at Waterloo will probably apply: "Hard pounding, this, gentlemen; let's see who will pound the longest."

Some years ago I submitted to the royal commission on labour a memorandum as to the conditions of British and foreign industry, published in their very voluminous reports, in which it was shown that, of the total production of steel in the five chief iron- and steel-producing countries, in 1870 and 1890, the part contributed by the United Kingdom fell from 45 per cent. in 1870 to 23 per cent. in 1890; that the per cent. of contribution of the United States rose from only 9 per cent. in 1870 to 50 per cent. in 1890; while within the same period the United States increased their proportion of the

total make of finished iron from 22 to 37 per cent., against a decline from 43 to 26 per cent. on the part of the United Kingdom. These figures sufficiently indicate the character of the movement that has been in progress during the last quarter of a century, and more recent figures need not be added.

When, however, we come to deal with the foreign trade of the same countries, a very different state of affairs is revealed. The following figures show the exports of iron and steel from each of the countries named relatively to its production of pig iron, wrought iron, and steel for 1895–96.

	Output 1=1000 tons.	Exports 1=1000 tons.	Percentage of output exported. Per cent.
Great Britain	11,824	2,883	24.39
Germany	9,593	1,523	15.87
Belgium	1,643	489	29.74
France	3,466	209	6.02
United States	15,886	91	0.57

These figures demonstrate the greatly-preponderating importance of Great Britain as an iron- and steel-exporting nation, despite the fact that the little kingdom of Belgium exports a larger relative proportion of annual output. Germany, moreover, has been creeping up with steady pace during the last few years, although, somewhat anomalously, she shows for the current year a large falling off, compared with 1896, while Great Britain shows an advance of nearly two hundred thousand tons. The most remarkable part of all, however, is the relatively limited export trade of the United States, which exported a little more than half of one per cent. of their enormous output of almost sixteen million tons. On the face of it it seems almost ridiculous to speak of a country so far behind in foreign trade at so recent a date as likely to do anything in the near future of which competitive nations need entertain the least alarm.

The United States, as every manufacturer and economist knows, have not entered the arena of foreign competition hitherto to any material extent, because of the enormous demands at home, and the aid lent by those demands, and by the maintenance of a protective system in keeping up prices. My friend, Mr. Edward Atkinson, of Boston, with whom I have had valued opportunities of discussing this subject, has shown* that the *per capita* consumption of iron in the United States has increased from 270 pounds in 1880 to 320 pounds in 1889, and that the apparent disadvantage of the United States in the cost of iron and steel from 1880 to 1890 has been about $700,-

*"The Industrial Progress of the Nation," p. 277.

000,000, in view of the results of the tariff.* While these two controlling influences were at work, prices were kept at a high level, and there was no incentive to attempt business in foreign markets. American manufacturers, moreover, had not yet set their house in order in the matters of low costs of mining, cheap transport, efficient labour, and modern plant—the four factors that have brought about the new revolutions, and threaten to repeat the history of the last century, when the American colonies exported considerable quantities of iron (charcoal) to England.

To enable the reader to understand the causes and the character of this new order of things, it is necessary to say something of the conditions which have been superseded.

The controlling factor is, of course, the cost of the pig iron at the steel works. This cost was necessarily high at a time—no more than twelve years ago—when the cost of assembling at the furnace the materials required for a ton of pig was 35s. at Chicago, 32s. to 34s. at Cleveland, and 35s. to 40s. at Pittsburg. † At that time transport alone, in some cases, appears to have counted for almost as much as the whole cost of production, transport included, at the present day. Among the many differences that distinguish American from British conditions, this is not the least important. With the iron industry of the mother country, circumstances have not changed so largely or so rapidly. Indeed, the transportation conditions of to-day are much the same as those of fifteen or twenty years ago.

The American iron industry differs from that of any European country in respect of two things: first, in the conditions of supply and demand; second, in the methods adopted by leading manufacturers in production and distribution. Mr. Andrew Carnegie, in 1896, declared that "the manufacture of iron and steel is subject to greater fluctuations than almost any other branch of business," and that "this arises from two causes: first, the demand caused by increased activity and development, as scarcely anything nowadays can be built without this material; and, secondly, because the amount of product cannot be rapidly increased. New mines have to be opened, new railways built, new blast furnaces and new mills, before much additional finished product can be obtained. This takes time, capital, knowledge. High profits of existing works tempt their proprietors to enlarge capacity, and inexperienced capitalists are tempted to engage in the manufacture. By and by, capacity far exceeds con-

* It is only fair to Mr. Atkinson to point out that in 1889 he predicted the export of pig iron from Alabama to England as a result of tariff revision.

† These are the figures that were given to the Royal Commission on Trade Depression, Dec. 16, '85 See Report, p. 361.

sumption, and then follow some years of depression, to be followed in due course by a year or two of great profits." *

But American methods have also at least as much to answer for as causes that appear to be a good deal more beyond control. Those methods are sufficiently well known to men engaged in the trade on both sides of the Atlantic. I need not again go over the well-trodden ground of the early history of the bessemer steel industry in the United States, or speak of the zeal, enterprise, *esprit de corps*, and mechanical genius of that highly capable band of then young men, who, under the guidance of my late and greatly-esteemed friend, Mr. A. L. Holley, took the technique of bessemer practice out of the European ruts, and placed it on a much higher level of attainment. Holley's example and aspirations have been a spur to all who have followed him as metallurgical engineers and works managers, and for at least a quarter of a century the constant aim of the Americans has been to "beat the record," or, in other words, to produce more cheaply than ever before. This spirit and effort have had the most ample encouragement from capitalists like my friends, Mr. Carnegie and Mr. A. S. Hewitt, who have always been willing to afford chances to those who believed in themselves, and who have recognized the importance of keeping up their manufacturing plants to the highest level of modern practice. This, of course, has been an exceedingly costly business. I am bound to say that the expediency of readily adapting equipment to modern invention has not been realised in any European country to the extent that it has been in the United States. It is still a debatable point whether the vast expenditure incurred in modern American iron- and steel-manufacturing plants is justified by results, and whether the British system of keeping down capital expenditure as far as possible is not, on the whole, more satisfactory. I have talked over this matter with many leading men in both countries, and have reached the conclusion that the differences in the circumstances of the two countries create essential differences, not only in the conditions to be met, but in the most expedient and economical methods of meeting them. In other words, it would hardly pay a manufacturer in England to make on his plant so lavish an expenditure as is common in the United States, because he has no guarantee that, when he has done so, he will secure orders to keep it employed. His prospects of home orders are certainly not sufficient to do so, and he cannot, like his American and German rivals, accept orders at more or less unremunerative prices in order to keep his plant going, for, unlike them, he has no protection behind

* "On the American Iron Trade," *Iron Age*, January 2, 1896.

him in his home market, nor has he—at any rate for the majority of his products—the more temporary advantage of a syndicated price.* All this means that, in a general way, the efficiency of a typical American plant is greater than that of a typical British plant. In other words, all other things being equal, the American plant will produce a larger quantity of material in a given time at a less cost, because it is specially designed and constructed with a view to that result. It is true that the American plant has involved a larger capital outlay, but the charge upon this difference does not amount to much, in view of the enormous outputs now usual in American practice. It is manifest, in this connection, that it would hardly pay European manufacturers to build and maintain equally costly plants, unless they attempted much more than they do at present in the way of securing orders from all parts of the world, without too closely counting the cost. *Cæteris paribus*, therefore, the American manufacturer has more efficient means of production than any European nation, and is likely to continue to have, so long at least as his own country affords guarantees of a demand that will keep his works fully employed, if he can shape his plans so as to secure the lion's share of the contracts.

It can hardly be without interest, and perhaps it may be of some use, if I set down an authoritative statement of the cost of the production of American steel rails twenty years ago at a leading Western mill. The metal used per ton of rails cost $41.83, which is four times as much as the cost of a ton of bessemer pig within the last few months; fuel per ton of rails, including bessemer department and rail mill, cost $5.65, whereas I know of at least two works—among the most important in the United States—where the cost of fuel per ton of rails does not now exceed 50 cents, or less than one-eleventh of the price then paid, while labour cost $11.15—$3.50 for commission and the rest at the mills—against a cost of less than $3.00 at the present time. The total cost of a ton of steel rails at that time was more than $69.00, whereas the total cost of a ton of steel rails to-day, under the most favourable American conditions, does not exceed $16.50, or less than one-fourth.

In Europe there have been no similarly extraordinary changes in costs and values, because no European country started from an equally high level in respect to both. The cost of bessemer pig iron, fuel, and labour has certainly varied in Great Britain, but within comparatively narrow limits, if we except the years 1872–74 and 1880–81; and as with Great Britain, so with other European countries. Probably the

* In some cases British manufacturers *do* have an understanding as to prices, but rarely on binding penalty terms.

greatest change of all has taken place in the cost of labour, which is not one-third of what it was a quarter of a century ago. Of course, also, there has been great economy in other directions, and one British firm is now, I believe, ahead of all others in respect of its bessemer plant, which has 20-ton converters against 5-ton converters employed at the same works a quarter of a century ago.

My own experience and information lead me to suppose that at the present time there is very little difference in the cost of producing steel rails in the best European practice, but American costs must continue to be somewhat less, if our American friends continue this ability to produce bessemer pig at 40s. per ton, or less. It is highly improbable that the same description of pig will ever be produced in Great Britain, Germany, or Belgum, at this low price, because these countries have to depend so largely on imported ores, and have not so cheap fuel as the United States. The item of labour at works is now a relatively small one, in all countries alike. Owing to the long distances over which American manufactured products have to be carried, the uncertainty that always waits upon freights, and the limited amount of shipping directly under their own control, the Americans will not, however, have so assured a position in the world's markets as they would have, had they the British conditions to deal with, apart from those attaching to raw materials; and therefore it seems to me that the race will always be more or less uncertain in its issue, and it is likely to be all the more so because of the rapid and large fluctuations in the home American demand.

Another obvious advantage possessed by American manufacturers is the greater absence in the United States of prejudice or conservatism, and the consequently more ready application of new ideas and methods. This tendency and its results have been well set forth in a recent issue of an American trade journal, in the following terms:

> The old order of things has been considerably upset by the introduction of labor-saving machinery in the great steel works of the country. This movement began several years since with the improvement of the steel rail mills, was brought to a highly-advanced stage of development in the Homestead works, leading to the memorable strike of July, 1892, and, since then, has been making its way in all departments of the iron and steel trades. Special progress has been effected, however, in the steel works. Here engineers have been working on independent lines in the several establishments, attacking time-honored methods with audacious ingenuity, in order to secure some advantage over competitors in cheapening production. Wherever work accumulated, or even a small force of men has been required, the engineer recognized a problem to be solved by the application of an improved mechanical appliance. Improvements of this kind are in many cases peculiar to the plant, being compelled by the manner in which the works were originally laid out, when enormous increase in production was not contemplated. Correctly-devised apparatus has enabled some rather antiquated establishments to put themselves in line with modern works in the

economical handling of material in intermediate processes of manufacture. If it had not been for these improvements, they would have had to fall out of the race, and await the coming of better times and higher prices.

And so it is in most American industries. Methods and appliances are less stereotyped than in Europe, so that hardly any two works carry on the same processes on exactly the same mechanical lines. We know less of these differences in Europe.

But American commercial practice differs from that of European countries perhaps as much as American technical methods differs from those of Europe. So much is this the case that I happen to have excellent means of knowing that the largest steel manufacturing firm in the United States last year made a very handsome net profit, while the next to the largest made no net profit at all. The American manufacturer knows that there are sufficient orders in his own home market to keep even his largest plants fully employed, if he can only make sure of them, and, as he knows the vast importance of working full time, every effort is made to that end, almost regardless of price in times of depression. British contractors, however, generally look first to a profit, and, if there is little or no margin, the work is probably declined, so that the plants are often kept more or less idle for considerable periods.

In 1876 Mr. (now Sir) Lowthian Bell, in a report on the Centennial Exhibition, at which he was a metallurgical juror, declared that, so far as skill of manipulation and general efficiency of work are concerned, he could "detect no difference between the old and the new country in the rolling mills. I had the opportunity of comparing two rail mills,—one turning out 70 tons per turn at Middlesboro (England), and the other 67½ tons in Pennsylvania. The number of men employed at the two was almost exactly the same, but the cost for labour per ton was fully 25 per cent. higher in America than in this country (England)." He adds that, "in one case which came under my notice in rolling bar iron, I found the price paid in America to be nearly double that paid in this country (England)." It was not, therefore, until a later date that the Americans began to wake up. Indeed, Sir Lowthian Bell mentions that in 1876 there was not in the United States a single case in which the American bessemer works used direct metal, whereby 5s. per ton of steel could be saved.

Upon two points of importance the conditions in the United States must have greatly changed during the last twenty years, or Sir Lowthian Bell must have been far out in his calculations when he wrote his report as a juror at the Centennial. In that report he states that "the native-born Americans evincé more than a disinclination to apply themselves to the severe labour of the mine and the

ironworks, and, in consequence, fresh hands are almost exclusively recruited from immigrants."* Elsewhere he says that, "on the whole, the men engaged in mining and smelting were not much better paid than were similar classes in Great Britain."†

It seems to me that, if there has been any one thing more clearly established than another in the history of American industry, it has been the marked disposition of Americans to apply themselves to "severe labour"—meaning thereby strenuous exertions maintained over an exceptionally long period. It is true that they have largely succeeded in getting rid of the most exhausting part of the old manual toil—in mining, by the use of mechanical coal-getters, steam shovels, etc., and in metallurgy by a whole series of mechanical improvements whereby the work of the blast-furnaceman, the steel-smelter, and the roller has become much more automatic than formerly; but Americans are generally content to work much longer hours than are worked in England, and, however much they may have inoculated immigrants with their own strenuous ideas and habits, it is manifest that the impulse to work at high pressure for long periods must have come from the native-born Americans originally, since the immigrants have no such records to show at home as are shown in the United States.

As regards the rates of wages paid in the iron works and kindred establishments of the United States, they were certainly much higher in the seventies, and over a large area are much higher still than in Great Britain. This is shown by Sir L. Bell's own figures‡ in 1876, 1884,§ and 1890.‖ A statement submitted some years ago to the tariff commission by the then vice-president of the Illinois Steel Company, my friend, Mr. W. R. Sterling, showed that the average annual wages paid to the then 9,500 employees of that great corporation was nearly £3 per week, and figures recently compiled by the *Iron and Coal Trades Review* show that the price paid for sheet rolling in a typical American works was stated to be $4.22 in England and $10.65 in America. But there is no need to labour over this point, for it is hardly nowadays disputed that the range of wages in American mines and works is, and has long been, materially higher than the corresponding figures for Great Britain, or for any other European country.

This, however, is not the real point at issue. We are not concerned so much with the nominal rate of wages as with the wages cost of a given product, which may be, and often is, a very different

* "Report on the Iron Manufacture of the United States of America," p. 37.
† Ibid, p 38.
‡ See Report of 1876, pp. 30, 31, 36, and 37.
§ "Principles of the Manufacture of Iron and Steel," pp 555, 562.
‖ "The Iron and Steel Institute in America in 1890," pp. 149, 183, and 198.

thing. The truth is that the higher rate of wages which they have been compelled to pay has been the salvation of American manufacturers from an international standpoint. This apparent paradox is easily explained. High labour-costs have compelled the manufacturers of the United States to exert themselves in so perfecting their equipment as to get rid of manual labour whenever that was practicable. The results of this necessity have been astounding in a large number of cases with which I have been made acquainted. I have been shown balance-sheets and cost-sheets for leading American works where the labour-cost was very much under anything I have ever heard of in any European country. The particulars so communicated were submitted under the seal of confidence, and therefore I can say no more about them; but they confirm the remarkable evidence of low labour-costs given by my friend, Mr. Franklin Hilton, in his interesting series of articles recently published in the *Iron and Coal Trades Review*. In one of these Mr. Hilton states that at the well-known Lorain works "600 tons of ingots have been produced in twelve hours, with only sixty men in the bessemer shop, including all labour." Now, if we take the average wages paid to these men at £3 per week,—it is likely to be materially less,– and assume that this rate of output can be maintained six days per week throughout the year, it would mean an average labour cost per ton of ingots of little more than 4½d. If it were maintained for one-half of the year, the labour-cost per ton of ingots would be only about 9d., and I know of no British works that can show anything like this low figure. *Mutatis mutandis*, the same remarks and conditions apply to the rolling mills and auxiliary departments of American steel-works. A ton of steel rails can be produced in Pittsburg to-day more cheaply as regards labour than in any other part of the world.

I purpose now to jump from the highest rate of wages, or nominal labour costs, to the lowest that exist on a considerable scale, because sharp contrasts have a tendency to accentuate notable facts. Belgium, which competes with Great Britain, Germany, and the United States in many neutral markets, does not, like the American steel works, pay an average wage of about £3 per week, or, say, £140 to £150 a year, but one of only £41 per year.* In other words, the average wages paid in a recent year by the Illinois Company to all its employees was considerably more than three times the average paid in Belgium to *all* similar employees. What was the comparative result? The average labour-cost per ton of finished steel in Belgium

* The most recent official report on the metallurgical industries of Belgium shows that in 1896 the average wages paid to *all* the hands employed in steel works was 3½ fr. per day which, converted at 25 fr. to the £ sterling, for three hundred days gives this figure.

—obtained by dividing the total ascertained finished product into the total wages paid—was 10.8 francs, which, while much lower than the Belgium average of a few years ago, is still considerably higher than the average of the best American practice. The average product per man in Belgium was, of course, much under the American average, whatever the latter might have been, and ridiculously short of the best American practice, as illustrated by the Carnegie works, the Lorain works, and other well-known establishments.

As for Germany, she labours under disadvantages which I have already named in respect of the comparatively higher cost of her production of pig iron. That cost, however, has been considerably reduced of late years, as the following official statement of average annual prices shows:

Years.	Bessemer pig marks or shillings per ton.	Basic pig marks or shillings per ton.
1890	79.83	60.96
1892	57.82	49.33
1893	52.00	45.54
1894	52.00	45.17
1895	52.00	45.63

These figures compare unfavourably with British prices for both descriptions, and rule Germany out of the competition, unless she can show compensating gains, and I do not believe that she can. I found, when going over Belgian and German works, two and a half years ago, that the labour-costs of production did not much differ from the British, so far as I know them, and in Westphalia the wages are much the same as in some leading districts of Great Britain.

I must now put in a short plea for quality of product, which is important, although not so all-controlling as price. In not a few cases, it is believed, British manufacturers produce a higher quality of product than those of any other country. In many other cases, it is believed, the American products are coarse and unreliable; and it is pointed out that, as the great aim of the manufacturers there is to get quantity, they give little attention to quality. There appears to be sufficient ground for both views, which I will not admit to be mere prejudices. It is not alleged that the Americans *cannot* produce a high quality at any cost. The question is: Does their general system admit of it? Now, if this idea continues to be entertained, whether justified or otherwise, it is to be presumed that the British manufacturer, at the same price, will get the preference—at least until the Americans have stood for more care and higher quality.

On a consideration of all the facts and figures, I must, in the main, express my substantial agreement with the views recently expressed

on the future industrial position of the United States in a leading American trade journal. The *Iron Age* has stated that "the United States is now entering upon the commercial career long ago seen to be its manifest destiny. Hitherto it has been in a formative or preparatory state. Its citizens have been engaged in the costly and arduous work of developing its natural resources, establishing intercommunication, diversifying industries, and endeavouring to supply their own requirements as far as possible. They have always raised surplus crops, and have helped to feed the world. They are now in a position to turn out more manufactured articles than they need, and are assisting to supply the wants of the rest of the world in that regard. Unless remarkable and calamitous changes take place, the United States will from this time be a large seller of all kinds of commodities, raw and manufactured, and a comparatively small buyer. This combination will surely make it the richest country in the world. No other nation on earth is so well situated to become the future workshop of the world. Nowhere else is food so abundant and cheap, with manufactures so well established and the finest raw materials so plentiful and accessible. In its ability to sustain itself the United States is unique among nations."

While this is "just so," it does not by any means follow that the United States will have it all their own way. It remains to be seen how far some European countries, and notably Great Britain, can in the future approximate American conditions, or, in other words, how long American manufacturers are to enjoy a position "unique among nations."

I have now, I fear, exceeded the limits assigned me for the present article; but, in a concluding paper, I hope to sum up the whole subject with a view of showing the extent to which different countries have occupied neutral markets, and reach reasonable conclusions as to the prospects of the world's iron trade in the future, regarding costs and conditions of supply, as well as the countries whose supremacy will be established and maintained.

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Automatic Stokers.

FOR several months past the Franklin Institute has been investigating the smoke nuisance, and the various methods for its prevention, not because Philadelphia is now suffering from excessive smoke, but rather because the increasing use of soft coal has caused apprehensions for the future.

The investigation took the form of a public symposium at the meetings of the Institute, many specialists from various parts of the United States contributing, either orally or by correspondence; the reports of these meetings form a valuable contribution to the practice in smoke-prevention in different sections of the United States.

Supplementing this discussion, another has been held upon the subject of mechanical stokers, and the publication of this portion of the symposium is begun in the *Journal of the Franklin Institute* (December, 1897). In the discussion a number of well-known mechanical stokers were illustrated and described, and there was evident appreciation of the advantages of mechanical firing, especially for those locations in which the demand for steam was fairly uniform and sudden fluctuation in load the exception.

A number of valuable points of practical importance in connection with the combustion of coal were also brought out, and some of these will bear repetition and emphasis. The fact that freedom from smoke does not necessarily mean economical combustion was in some cases fully understood. As one of the contributors remarked:

"The fallacy of the general notion that a clear stack signifies economy, and that a smoky stack means wastefulness, is being appreciated more and more. The principal loss from the incomplete combustion of gases is not indicated by the appearance of the chimney mouth, but is due to the escape of invisible gases, and the visible smoke formation is a rather insignificant item of loss. The experiments

of Professor Tatlock, of Scheurer-Kestner, and those made at Sibley College all tend to show conclusively that the average heat losses due to the formation of smoke do not exceed three-quarters of one per cent."

Smoke-prevention is rather to be regarded as a measure of public hygiene and cleanliness than as a problem in the economical generation of steam, but in all large cities the former conditions should rule, even at the expense of economy. Neglecting, then, the question of the value of smoke-prevention as a measure of economy, automatic stokers may be considered upon their merits, merely as substitutes for hand-firing; and in very many instances, remarkably good showings have been made. As one of the speakers said: "All stokers are good, but some are better than others." The constant and uniform feeding of the fuel is undoubtedly conducive to thorough combustion, and with the traveling grates used in many forms of apparatus, a clean fire is assured. One source of economy resulting from mechanical firing is the greater length of life of boiler when freed from sudden changes of temperature. To quote the experience of an extensive user: "The heat in the furnaces being maintained so constant and regular, the time lost in overhauling and repairs of the boiler was very much reduced—an entirely unexpected source of saving and safety."

So long as coal continues to be burned directly under the boilers which are to receive the heat, there is little doubt that mechanical stoking offers material advantages over hand-firing. It seems, however, to be but a partial solution of the problem, and some day perhaps we may wonder why the barbarous practice of burning fuel within city limits and discharging the products of combustion directly into the atmosphere was ever permitted.

In the words of a review of this subject in these columns written several years ago: "The use of gas-producers and the methods of using producer gas are surely well enough known to bear wider application than has yet been given, and the present practice of firing each boiler independently is not much less primitive than would be the use of separate gas retorts for the production of illuminating gas for each establishment. The introduction of electrical methods of distribution of power would make it altogether possible to have power-generating plants placed entirely outside the limits of our large cities, and enable vast batteries of boilers to be fired with smokeless gas, generated from the lowest grades of coal in independent producers; while the power developed in engines of highest efficiency and transmitted and subdivided by electricity might almost rival in cheapness that which is to be obtained from Niagara. That such a plan contains some of the elements of experiment cannot be denied, but that the uncertainties, either of cost or construction, are greater than those of the control of the great cataract may well be doubted; and the entire elimination of the smoke problem would be included as what might perhaps be termed a negative by-product."

Since these words were written, the control of Niagara has become a fact, and the question of gas-firing is progressing with some success; but much remains to be done before the clouds of smoke and steam shall cease to obstruct the light, and foul the air, of the cities of America.

Electric Tramways in New York.

ONE of the most important installations of electric traction yet constructed, and certainly *the* most important underground system, is that of the Metropolitan Street Railway Company, of New York, of which an excellent illustrated account is given in the *Street Railway Journal* (December, 1897).

New York city, from its peculiar topography, is especially adapted for mechanical or electrical traction. The long, narrow shape of Manhattan island, and the concentration of business at one end and residences at the other demand a rapid and efficient transportation service almost of a miniature trunk-line nature.

The unalterable opposition to the overhead trolley has retarded the introduction of electric traction in New York,

but the great increase in travel, and the manifest inadequacy of the Broadway cable line and the elevated railroads to meet the demands of the public, have compelled the management of the Metropolitan system to install the underground electric trolley.

The system adopted was of the simplest nature, consisting of a conduit containing two conductor rails suspended from porcelain insulators, and transmitting the current through suitable contact shoes to the motors upon the cars. The road-bed, conduit yokes, and concrete masonry are of the most substantial construction, the weight of rails and yokes being greater than has been employed in any previous road, and the work, which has been in progress for the past three years, is now nearly completed, a portion of the road being already in operation.

It is impossible, in the limited space here available, to go into a detailed description of this great work, and reference should be made to the article above noted both for details and for illustrations of the unfinished work. The difficulties encountered were many and great, especially at important intersections and in the older parts of the city, where pipes, sewers, and electrical conduits were constantly encountered. Obstacles of this nature added much to the cost of the work and caused it to vary much in different localities. It is estimated, however, that the average cost per mile of single track, including excavation, feeders, conduit, and all material employed, has been about $100,000 (£20,000).

The general method employed was as follows. After the street had been excavated for a width of 18 feet 9 inches, a depth for a conduit of 30½ inches, and between tracks of 15 inches, the yokes were placed in position. The track and slot rails, and iron lining of the conduit, were then laid on the yokes, and bolted in place. The tie rods were then inserted, and the whole structure blocked up, surfaced, and lined. The concrete, formed of 7 parts of ¾-inch broken stone, 4 parts of sand, and 1 part of Portland cement, was then placed under and around the iron sheathing, after which the earth was replaced, and the street was repaved. The actual time which elapsed between the opening of a section and street and the time when the track was paved up averaged from ten to fourteen days."

The system provides a complete metallic circuit through the insulated conductor rails,— the track rails not being used as a return,—and the ordinary 500-volt system is employed, the feeders being carried through separate underground conduits at the side of the main conduit.

A notice of the great power station now in course of construction is given elsewhere in this issue, and the entire plant, when completed, will include 59 miles of single track, operated by 70,000 h. p., the whole forming the greatest power plant in use for any purpose.

The Performance of Screw Propellers.

ALTHOUGH the screw propeller is acknowledged to be the best and most efficient device known for the propulsion of vessels, there is yet much to be learned about its performance under various conditions. Many of the ablest engineers and mathematicians have given it their attentive study; yet in very many instances we find experimental changes necessary before the propellers of new vessels can be made satisfactory, and it is to the results of experiment, discussed in full knowledge of theoretical principles, that we must look for further information.

The most extensive and reliable experiments which have, until recently, been made are those of Froude, published in 1886; but these covered only a portion of the problem. A new series of experiments has been inaugurated by Professor W. F. Durand, of Cornell University, and a preliminary paper giving some account of the work was presented by him before the recent meeting of the Society of Naval Architects and Marine Engineers at New York, and published in *Marine Engineering* (December, 1897).

Professor Durand describes the performance of a screw propeller as involving the following features: the work absorbed, the thrust developed, and the useful work

returned, the ratio of the first to the last giving the efficiency. The performance depends upon the dimensions of the propeller and the conditions of its use; the former including diameter, pitch, and area, the latter including revolutions, speed of advance, and slip.

After stating the formula for the useful work of a propeller, which is assumed to vary as the square of the dimensions and the cube of the speed, the object of the experiments is stated to be the derivation of data from which values of the factors for any particular propeller may be determined. In these experiments it is intended that the diameter, speed of advance, and shape and number of blades shall be kept constant; while the amount of blade area, pitch or pitch-ratio, and revolutions or slip, shall be varied. In this preliminary paper only a portion of the work has been carried out,—namely, that relating to the effects of change of area. A number of propellers were made, using the same pattern in each case, but paring down the pattern for each successive casting, thus obtaining a series of propellers, identical in all respects except area; with these the experiments were made.

As no experimental tank was available, the apparatus was mounted on the bow of a small steamboat, the propeller to be tested projecting forward into the undisturbed water, and the speed being under control. The propeller was rotated by a small rotary engine, the motion being transmitted by cord and pulleys, and ingenious recording instruments measured the power, speed, and number of revolutions, while the thrust was observed on a mercury pressure column.

The results were reduced to a constant pitch ratio, as well as to a constant number of revolutions, and curves were plotted through the points thus obtained, showing very clearly the relations of area, thrust, slip, and work. Of these diagrams the most interesting is that giving the information especially sought in this especial series of experiments,—the relation of thrust to area.

We know that for a given slip there is some maximum thrust beyond which we cannot pass, no matter what the area. We also know that, when there is no area, there can be no thrust. Starting with zero area, the thrust at first varies nearly as the area, but increases at a slower and slower rate with further increase, until the maximum is reached, after which, for increase of area, the thrust either remains constant or slowly declines. The curves of Professor Durand's tests show that this maximum was reached with an area ratio of about 0.63, but that the change was very slight between the area ratios of 0.54 to 0.72, the tests all being made on a four-bladed propeller, with a pitch ratio of 1.3. The thorough manner in which Professor Durand has carried out and discussed this first portion of the tests gives added interest to that which is yet to come.

American Locomotive Building.

THE success which has attended the efforts of American locomotive builders to establish a market for their engines in countries heretofore considered permanent customers of English manufacturers has caused some interested inquiry on both sides of the ocean, especially as it is understood that the American engines cost less than those of British make, while at the same time the workmen in the United States receive decidedly higher wages. This matter is discussed in an editorial in *Locomotive Engineering* (December, 1897), and some interesting points as to American methods of production are made.

One of the principal reasons for the fact that locomotives can be built cheaper in America than elsewhere lies in the application of Whitney's system of gage and template working to the shop practice. With this came the application of piece-work prices and methods, since duplicate work rendered the piece-work system advantageous both to manufacturer and workman.

"American workmen are so much accustomed to piece-work that very little sentiment exists against it. Piece-work has encouraged mechanics to devise improved tools and perfected methods in doing their work, and the extraordinarily low cost of labor on some machines has

resulted from the use of ingenious tools produced by the workmen and patented by the inventors."

"When a machine tool has been put upon the market which promises to reduce the cost of production, the men in charge of every first-class locomotive shop in the country proceed to calculate whether or not it would pay to throw out a good tool to make place for the latest article. They generally decide to purchase the new tool. These are the influences which are giving the United States locomotive builders the markets of the world."

Wages are lower in Great Britain than in America, but the labor product of the American workman is greater in proportion than his wages. A locomotive built in Scotland represents more than twice as many labor hours as an engine built in America, and the cost of the American engine is less, notwithstanding the higher wages received by the men.

As Thomas Carlyle put it many years ago: "*Tools* and the man I sing"; and it is the question of what tools he uses which decides what the man shall do not only with his work, but with himself.

Geared Locomotives.

LOCOMOTIVES in which the motive power of the engines is applied to a number of axles by use of some form of transmission-gearing have been in use for a number of years; especially on the rough logging roads in the lumber regions of the United States such engines have been found most acceptable in service. The idea of driving a number of axles in a train by means of a longitudinal shaft with universal joints, and bevel-gear connections is by no means new, it having been one of the many suggestions made in the early days of locomotive experiment, when it was feared that the adhesion of the engine drivers would not prove sufficient, even on level rails; but, when the success of the Rocket demonstrated the contrary, the geared engine was relegated to obscurity, along with the rack locomotive, until special conditions should appear to warrant its revival. A very full review of some of the later designs of geared locomotives is given in *Engineering News* (December 9), and, in view of the real value of such engines for some purposes, we make extracts.

Geared locomotives, by virtue of their superior tractive power, are especially adapted for use on lumber and mining railways having very rough and light track, with heavy grades and sharp, irregular curves. In engines of this class the entire weight is utilized for traction. Each truck is independently driven, and is at the same time permitted to turn independently, — a combination which permits sharp curves to be passed successfully, while the distribution of the weight over a large number of widely-spaced wheels enables light, roughly-laid track to be used.

Geared locomotives may be divided into two classes, according to the arrangement of the gearing. One form includes engines having outside longitudinal shafts with bevel pinions engaging with bevel wheels attached to the outside faces of the driving wheels; the other style is made with inside shafts, the gearing being mounted on the truck axles. By the use of proper gear ratio the speed of the engine shaft may be increased to double that of the truck axles without causing undue vibration, and thus smaller cylinders used than would otherwise be possible. This feature is of especial value when the slow speed of the logging train is considered, and is another reason for the acceptability of the geared engine in either form for this service. The outside shaft form was the earlier variety of geared locomotives, and many engines of this type have rendered good service, some as large as eighty tons in weight having been built for mountain service. The objections to the outside shaft are the severe twisting strains thrown upon the frames and journals, as well as the exposed position of the working mechanism, and the dripping of oil upon the track.

These defects are obviated in the second type, with central shaft, and some very satisfactory engines of this type have been constructed. Notwithstanding the criticisms of the use of gearing on locomotives,

experience has shown that for certain classes of service offers positive advantages. Spur gearing behaves well on electric trolley motors, and the principle of independent axle-driving is there generally accepted as correct. The Heilmann electric locomotive is an example of this method applied on a large scale, and, indeed, one of the especial advantages which is expected to follow the use of electricity as a motive power on trunk-line railways is the distribution of the driving power among all the axles. Ultimately, no doubt, independently-driven axles will be the rule, and not the exception; but, until the more general introduction of electric driving, the geared steam-locomotive will hold its own for the uses to which it is now applied.

A Large Power Plant.

ONE of the immediate results of the development of improved methods of transmitting and distributing power has been the construction of larger power installations than would have been constructed for ordinary industrial operations. In large iron works and similar establishments the total aggregate of power is often very great, but it is generally divided among several centers in order to reduce the inconveniences of transmission.

Probably the largest concentrated power plants in existence, at least until very recently, have been found in the engine and boiler rooms of the great ocean liners, where units of 10,000 to 15,000 h. p. are in use, and where aggregates of 20,000 to 30,000 h. p. have been reached in several instances.

The new power house of the Metropolitan Street Railway Company, in New York, however, will, when completed, be far greater in capacity than any plant now in existence, either afloat or ashore, as it is planned for 70,000 h. p.

A fully-illustrated account of this great power plant is given in *Power* (December, 1897), from which some of the more important data here given have been obtained. Since the sole purpose of the installation is the generation of current for tramway service, the arrangement of the plant is comparatively simple, the generators being coupled directly to the engines, no intermediate transmission being used.

The plant, as planned, is to consist of eleven vertical compound engines, nominally of 4,000 h. p. each, but capable of developing 6,600 h. p. The high-and low-pressure cylinders are mounted on separate columns with the revolving field of the generator on the shaft between them, the generator foundations being provided with rails to enable the outside armature to be shifted to one side, and permit access to the fields for inspection and repair.

The generators will supply an alternating current of 6,000 volts' tension, which will be led at this voltage to substations and there converted into a direct current of 550 volts, by use of static transformers and rotary converters, for supply to the conductors in the conduits.

The boiler rooms adjoin the engine room, and consist of three floors of water-tube boilers, each floor containing twenty-nine boilers of 400 h. p. each. Over the boiler room is a steel storage bin for coal, having a capacity of about 9,000 tons, with chutes delivering coal to the boilers on any floor, the bin being supplied by a conveyor taking the coal direct from vessels at the dock at the end of the building, while ash chutes and conveyors are arranged to remove the ashes mechanically.

Many of the mechanical details of this great plant are worthy of more extended notice than can be given at this time; as the work progresses, further accounts will be forthcoming.

The Armor Plate Board.

THE report of the board appointed by the congress of the United States for the purpose of ascertaining the probable cost of equipping and operating a government armor-plate plant has been discussed at length in the *Iron Age* (December 9 and 16, 1897), and contains much interesting information. Prior to the publication of the report it had been assumed that a plant could be obtained at an expenditure of about $1,500,000 (£300,000), and the

question under consideration seemed not so much the advisability of undertaking the construction of the plant, as the determination of the best location for it.

Before deciding upon a location, however, the board undertook to examine into the actual cost of a suitable plant, and secured as expert Mr. John Fritz, undoubtedly the very best man in the United States for the purpose. Mr. Fritz went to work with his accustomed thoroughness, and in a few months produced a detailed estimate for a modern armor-plate plant, showing the cost to be $3,750,000, (£750,000) exclusive of site. While this seems a large sum, the manner in which the estimate has been prepared renders it more than usually reliable. Everyone knows that nearly all public works exceed very materially in cost the original estimates; but, knowing Mr. Fritz's familiarity with the subject, and his experience in similar undertakings, there is every reason to believe that a complete modern plant could be obtained at a figure corresponding to his estimate.

The original cost, however, is not the only matter to be considered. In order to produce armor-plate at a reasonable cost, it is necessary to run the plant at its full capacity, regardless of the demands for armor. The conditions of the economical production of armor plate are not greatly different from those of other lines of industry, and it is only by a full and continuous operation of the plant as a whole, that full operative economy can be realized. This is also necessary if the skilled staff is to be kept up to the highest degree of efficiency, and the latest improvements in the art adopted promptly.

This means that an outlet must be provided for about 6,000 tons of armor plate—equivalent to the equipment of two large battle-ships—every year. If such an outlet is not provided, the full capacity of the proposed plant, which must of course be equal to such a demand in case of need, will ordinarily be far in excess of the requirements of the government.

It is practically this unequal demand for the product which leads private firms to base the price for armor upon the cost of maintenance rather than of actual production, and it is difficult to see how any other method could be followed.

If the government contemplates a continuous construction of battle-ships, until the American navy attains the proportions of that of Great Britain, it is possible that, even at the cost estimated by Mr. Fritz, an armor plant might prove an economical investment. If, on the contrary, the outlet for the product of the plant is to fluctuate with the views of changing administrations and the influences of party expediency, it is hard to see how any advantage is to be gained by the construction of a government plant; and, should the work be undertaken, Uncle Sam may find, as he has already found before now, that he has paid too dear for his whistle.

The Education of Engineers.

THE report of the committee of the Society for the Promotion of Engineering Education upon the matter of the entrance requirements for engineering colleges has brought out some discussion, both editorially and by correspondence, in the columns of the *Engineering Record* during the past month, and the importance of the subject warrants its further notice here.

It is undoubtedly true that the average graduate in engineering does not possess such a general education, or even such a command of the English language, as a professional man should have. Many professional engineers of ability are lamentably incompetent to write a clear report or careful advisory letter, and in matters involving discussion or argument, or the presentation of engineering subjects before committees or organizations, a command of English and a confidence of expression is a valuable auxiliary which too many men lack.

One of the great defects in the preparatory schools is that they attempt too much, or, rather, that they endeavor to teach too many things; as a result, many of the subjects are taught superficially, or even improperly. It is the general testimony of professors of physics, chemistry, and similar branches in technical schools

that the preliminary instruction in these subjects given in the preparatory schools is of little or no value. It is much better for the student to devote his time of preparation to English, mathematics, drawing, a general acquaintance with history, and the elements of one or two modern languages, than to spread his energy over a much larger range, including ground which he must subsequently re-traverse, perhaps to get rid of his misinformation. Above all, he should be taught to express himself clearly and effectively, both orally and in writing, and, when with this he has really learned how to study, he may fairly be considered ready to take up the professional portion of his education.

There is one portion of this subject, however, which as yet has not received the attention which it properly demands. In most cases it is considered that a scientific or professional education rather unfits a man for a business career. Now, while an engineer should not be expected to be a business man in the fullest sense of the term, yet the very nature of his work makes many demands of a business nature upon him. How often we find men of high professional attainments earning far less than their abilities warrant, just for lack of the business knowledge and training by possession of which some otherwise inferior man reaps the fruit of the other's skill and labor. It is not only scientific knowledge that should be acquired, but the art of utilizing it as well.

Animated Pictures.

An interesting article in the *Popular Science Monthly* (December, 1897) describes some of the more recent forms of apparatus for the projection of animated pictures, and also adds suggestions for some applications which offer interesting possibilities. Instead of taking the original photographs from ordinary objects in rapid motion, it is possible to make them at much longer intervals, such as hours, days, or weeks, so as to obtain successive views of objects of which the changes occur but slowly, such, for example, as the growth of a plant, or even of a human being. These images could then be exhibited at such a rate of speed as to appear quite continuous, thus exhibiting to the eye the growth of a plant or the blossoming of a flower in as short a space of time as is claimed by any Hindoo fakir, and with far more truth.

"Such views could not fail to produce an effect at once marvelous, unique, and instructive. As pictured upon the canvas, the plants would grow and develop before the eyes of the onlookers, throwing out leaf upon leaf and visibly increasing their dimensions. Here and there a flower or flower-cluster might make its appearance, the individual blossoms bursting forth suddenly, and remaining visible for a brief period only. As object-lessons in botany such motion-pictures would be invaluable, while the general public, not less than the advanced student of science, would regard them with feelings of keenest interest."

But there is another possible application of scientific value and interest. Many phenomena which it is most important to investigate carefully occur too rapidly for the eye to perceive with accuracy, and the study of such subjects is beset with difficulties. Photographed upon a rapidly-moving film, however, the occurrence may be repeated again and again, until all its details have been observed, and, as the rate of speed of the projecting film may be reduced, the critical point of the phenomenon may be caught and identified.

For example, a piece of metal may be placed in a testing-machine and a continually-increasing stress applied until the elastic limit has been passed and the point of rupture reached. During this entire time a continuous film might be filled with photographs, constituting a complete visual record of the test, which could then be examined at leisure at as much slower speed as desired, any number of times, and, by comparison with the graphical record of stresses and strains, add materially to our knowledge of the subject.

These are but isolated examples of the possibilities of the cinematograph as an instrument of scientific research and other applications will readily appear.

THE BRITISH PRESS.

English and American Freight Cars.

ONE of the important factors in comparing the cost of production of manufactured articles in England and the United States is the relatively lower cost of freight transportation in America over that in Great Britain.

An article in the *Iron and Coal Trades Review* (December 17, 1897), in discussing this subject, calls attention to the much larger size of the American freight cars, and shows the great economy resulting from the use of large cars. In England nine to ten tons is the maximum capacity of goods-waggons, while in the United States the capacity of cars has been increased between 1876 and 1881 from 20,000 to 40,000 pounds, with an increase of only 1,500 pounds in the dead weight, the increase corresponding to a gain of more than 15 per cent. in the paying carrying-capacity. During the past few years a still greater increase has been accomplished, and cars have been made in some cases of as great capacity as 40 to 50 tons especially for the ore carrying trade

After giving some illustrations and description of large American steel freight cars, and noting the various elements of economy in repairs, resistance, and care, in addition to the increased carrying-capacity, the writer proceeds to urge the question of larger cars upon the managers of British railways.

"If in this country (England) we cannot cheapen the cost of our railways, which stand at the unprecedentedly high capital value of £50,000 ($250,000) per mile, we can at any rate cheapen the cost of working them, and in this direction our railway managers are likely to give increased attention to the building of larger and lighter cars. If by this means they can reduce the tare on mineral traffic by only 20 per cent., they will have done a good stroke for economy, but, in the light of American experience, better results than that should be possible."

Foreign Machinery in England.

THERE has been some correspondence in the columns of recent issues of *Engineering*, bearing upon the subject of the influx of foreign machine tools into England, which expresses more clearly the real condition of affairs than anything else yet published. Referring to the reason why the travelling salesman from America is received and welcomed by the English purchaser, one correspondent remarks: "The traveller from the States offers machine tools of a class such as are not produced in Great Britain. As an instance, I will take an industry with which I have no connection—the bicycle trade. At the present time thousands and thousands of pounds are going to America for automatic tools to make bicycles. This is not because bicycle makers hate their own countrymen, but because they positively cannot get these ingenious and beautifully-made machines at home. The cycle trade is crying aloud for machinery; makers are in despair because they cannot get it for their spring order work, and yet England cannot fill the gap—no, not even Manchester! Yet the cycle had its origin in England, and was a large industry here years before it was much more than thought of in America."

A number of instances are also cited in which English firms practically declined to undertake the construction of special tools, while the representatives of German firms investigated the matter and designed and built special machinery for repetition work under guarantee, securing the original and subsequent orders.

Another correspondent puts the case still more strongly. Says he: "The fact is, the average machine-tool maker is a kind of Rip Van Winkle. He has been asleep for twenty years, and it is only recently that he has been roused. Even now he is not fully awake, and he finds the bustle of the modern world very annoying. He would like to hush it into a

state of repose more congenial to his feelings, and so he sends to the papers some recollections of the past, and calls them 'Suggestions for the Future.' It is a future which will never be realized."

The American salesman's method of doing business also comes in for a share of notice.

"He thoroughly understands his business, and has plenary powers to conclude a bargain. He can pick up a piece of work and say: 'I will guarantee to make you a machine to turn out these at so much a dozen, and the price will be so much.' The Englishman says: 'I will make a note of your requirements, and our firm will write you on the subject.' What is the use of taking a commercial traveller into your works? You can get no ideas out of him, and the ideas you put into him get sadly changed before they reach his principal. We don't take strange Americans into our confidence because we love them, but for the sake of what we can get out of them; and we don't pay them more than we can help."

Maltese Architecture.

A RECENT paper before the Royal Institute of British Architects by Mr. Arthur S. Flower, entitled "Notes on Renaissance Architecture in Malta," contains much that is of interest and value in connection with renaissance architecture in general, and in relation to the buildings of the Order of St. John in particular. As Mr. Flower truly says, most people think of Malta as little more than a British military station, and possibly as at one time the headquarters of the Knights Hospitallers, though, as a matter of fact, the little island teems with huge buildings, the product of many centuries of activity and ambition.

Owing to the abundant supply of an excellent and easily-worked building stone, the buildings of Malta furnish examples of most admirable masonry construction, and, because of the ease with which the material could be carved and the abundance of skilled artist stone-cutters, many of the buildings show a richness of detailed ornament rarely found elsewhere. Mr. Flower says: "I have been several times assured, on credible authority, that, even down to our own days, the custom in Malta as regards masonry has been that carved work, however elaborate and varied, was never reckoned or separately charged for in building contracts, but thrown in as a matter of course, and rather by way of pleasure to the workmen. And yet this Maltese stone, so fascinating to handle, weathers, as a rule, so excellently that three or four centuries seem to make no damaging impression upon the fine-wrought ashlar with which every building, great or small, is clothed."

The principal building which Mr. Flower describes and illustrates is the cathedral at Valletta, the capital and largest town. This is an excellent example of the renaissance architecture of the middle of the sixteenth century, modified by the conditions of the order, and also greatly benefited by the use of genuine carving instead of the flimsy stucco so much in evidence in Italian buildings of the same period. The peculiarities of the building lie mainly in the proportionally less height of the arched roof of the nave, and also in the arrangement of side chapels for the branches of the order in different countries.

The characteristic features of Maltese architecture were well brought out in the discussion on the paper. Among the speakers, Col. Prendergast remarked that, "in discussing these things one often failed to recollect the purpose for which these buildings were erected. They were not erected in order to make merely a pretty church;—this proceeding had been left to the Victorian era;—they were built for a specific purpose. There were half a dozen or more—seven, he thought in all—*langues*,—*i. e.*, lodges of the order,—whose business it was to deal with the work in different countries, and this church was merely a series of chapels; the *langue* of each country having its own chapel, which opened into a spacious hall with a barrel vault over it, and this was the nave of the church; but the *raison d'être* of the whole building was this series of chapels."

An interesting feature about the renaissance work in Malta is the evident influ-

ence of the nationality of the grand masters of the order upon the style of architecture, and especially of decoration. The several Spanish grand masters, of whom there were several in succession, brought in Spanish ways, and Spanish balconies can be found affixed to Italian buildings, while in other structures Spanish influence can be seen very plainly. During the following century the last grand masters, who came from France, introduced French details, and thus the various nationalities, one after the other, impressed in some degree their artistic feeling upon the buildings of the order, the fundamental style, however, always being that of the Italian architects and workmen.

Altogether, Mr. Flower has called attention to a phase of renaissance architecture which has been too much neglected, and which might be studied by modern architects with undoubted advantage.

Incandescent Gas Mantles.

IN view of the extending use of the incandescent system of gas illumination and the unequal illuminating power which has been experienced with mantles of various kind, any really scientific investigation into the relative value of different mantles is a welcome addition to our stock of technical information.

An interesting report of a number of tests of such mantles is given in the *Electrical Review* (December 10)by Mr. E. A. Medley, with much valuable information in general about incandescent gas lightin . Mr Medley had made some tests on mantles of the Incandescent Gas Light Company's mantles in London as long ago as 1893, and these he refers to as showing the improvement which has been made since that time. The tests referred to in the present report were made in Berlin, and include not only the two English mantles of the Sunlight and the Incandescent Gas Light companies, but also those of the German concerns, including *Die Deutsche Gasglühlicht Aktiengesellschaft, Die Neue Gasglühlicht Aktiengesellschaft*, and the *Stabil Mantel.*

The standard of light used was the Heffner amyl-acetate lamp, in connection with a Lummer-Brodhun photometer, the gas being measured by an Elster experimental gas meter. Much care was taken to secure uniform and reliable results, the room being thoroughly ventilated, and draughts at the same time avoided, as it has been found that the light is materially affected if there is not an ample supply of fresh air. The horizontal candle power was measured in three directions, 120° apart, and the mean taken as the correct reading, the measurements being taken every twenty four hours. The details of the tests are given in full in the paper, and we can here give only the final table, which contains practically all the important results; it will be noticed that one of the German mantles, the Stabil mantle, is decidedly superior to any of the others, either English or German.

Make of Mantle.	Candle Powers.			Percentage fall in.	
	New.	100 hrs	500 hrs.	100 hrs.	500 hrs.
Sunlight Company.. .	36	33.4	14	7	61.2
Incandescent Gas Light Company...	52.9	49	29.7	7	43.8
Deutsche Gasglühlicht Aktiengesellschaft .	70.3	49.7	28.2	29	59.9
Neue Gasglühlicht Aktiengesellschaft..	53.5	40.3	33.3	25	37.7
Stabil Mantel	62.6	57.1	47.5	9	24.1

An important feature in connection with incandescent gas burners is that of the proportion of the size of the mantle to the Bunsen burner. In many cases the mantle is much too large for the burner, and, in consequence, does not become properly incandescent all over; it also shrinks and warps out of shape to a much greater extent than when smaller. Tests also showed that the light absorbed by mica chimneys as compared with glass ones was as much as 9.4 per cent.

Mr. Medley's general conclusions are summed up as follows:

"The mantles give a wonderfully good light when new, but the extreme rapidity with which the light falls off, and the con-

sequent shortness of their efficient life,even when treated with every consideration due to their somewhat delicat constitutions, makes them far from an ideal illuminant. With the possible exception of the Stabil mantles, a great deal of improvement is necessary before, for domestic lighting at any rate, they can be considered even satisfactory."

To us this conclusion seems rather too sweeping. It is undoubtedly true that there is room for much improvement in mantles of all makes, but, when we see, by Mr. Medley's own tests, an average light of 50 candle power produced by a consumption of only 4 cubic feet of gas per hour, even an efficient life of 500 hours is not too short; and when, as he suggests, the price of mantles is likely, upon the expiration of the Welsbach patents, to fall to less than 4 1-2 d. each, which is now the price for good mantles in Berlin, the question of the life of the mantle will become a matter of minor importance.

Healthful Buildings.

MODERN investigations into the causes of disease and the best methods of disease-prevention have led us to look for sources of ill-health in many places formerly neglected. This is especially the case in connection with house-building, and there are many apparently minor details in connection with building construction which have an important bearing upon the health of the occupants.

The Sanitary Record (December 10, 1897) contains an excellent discussion of this phase of building construction, by Mr. Peter Fyfe, whose position as chief sanitary inspector at Glasgow gives him abundant opportunity of knowing whereof he speaks.

Speaking especially from the standpoint of the carpenter and joiner, Mr. Fyfe says: "A healthy house must, firstly, be dry in every part; secondly, it must be able to be thoroughly cleansed throughout; and, thirdly, it should leave no facilities within the four walls for the harbouring of infective or other dust."

The protection against dampness is mainly to be found in the work of the mason, and, unless a real damp-proof course is put in the walls, or if a damp site is not protected by a layer of concrete or asphalt, the work of the joiner becomes seriously affected. Not only wood, but also bricks when exposed to dampness, become the prey of fungi and moulds, producing rottenness and disintegration.

A frequent source of foulness in cellars and lower floors of buildings unprovided with concrete or asphalt coverings is the access of ground air. Many sites which seem dry and comfortable to the eye may discharge large quantities of ground air into cellars and similar spaces, owing to the rise and fall of ground water beneath. This ground air contains a large proportion of moisture, and speedily causes decay, and possibly disease.

One point especially emphasized by Mr. Fyfe is the reprehensible practice of covering up damp walls and partitions with woodwork, and thus endevoring to conceal the evil which, instead, should be eradicated. This is also true of all woodwork formerly so extensively used to enclose plumbing around sinks, baths, and water-closets; the removal of this useless work also conforms to the second and third conditions,—as to the facility of cleansing and the removal of dust lodgments.

Among the various obnoxious dust-holes Mr. Fyfe is especially severe upon the enclosed lofts and roof-spaces so common in many houses, more particularly those having peaked or sloping roofs. These spaces form storehouses, not only of microbes, but also of close, stuffy, and contaminated air, and are often constructed without openings for light or ventilation,—conditions under which cleaning is an utter impossibility. The remedy for this state of affairs may be found in the adoption of the flat roof which both eliminates the dusty cavern, and provides an area for a playground or space for washing.

The sliding sash window also comes in for a share of condemnation. "Here we have a long, hollow box for the weights, which in time becomes a dust chamber,

and one peculiarly situated in the direct line of the air-supply to the room. It must not be overlooked that through the chinks left all around our windows the large proportion of the fresh air to the room enters; and incoming air should not, if practicable, be caused to pass through or over any chambers or hollows where dust and dirt, to say nothing of fungoid growths, are permitted to lodge." The French hinged windows are free from most of these objections, or, at least, can be made so more readily than the sliding sash; and, besides, they admit of the outsides of the windows being cleaned from the inside of the apartment.

Another place for the lodgment of dirt is the picture moulding now so generally found in residences, nailed around the wall to permit the hanging of pictures without the necessity of driving nails into the plaster. "This forms a very comfortable situation from which myriads of microbes may select their time for pouncing down on the unsuspicious tenant. In ninety-nine cases out of a hundred, on inspection, this elongated dust-shelf will be found completely covered with the germs, mixed up with all the inorganic *débris* continually floating about in our atmosphere.

"Surely a room can be made quite æsthetic-looking without resort being had to such shelvings and crevices. Hygienic conditions and æsthetic conditions should, if at all possible, meet and go together, the one helping the other; and, I think, if joiners, plasterers, and other tradesmen set their minds against encouraging shelvings of this kind, we would have sweeter and cleaner houses than we have at the present time."

English and American Machine Tools.

IN an interesting article entitled "Some Lessons of the Stanley Show" (*Engineering*, December 3, 1897) Mr. Joseph Horner institutes between English and American machine tools comparisons which are especially in point at the present time. The special tools exhibited at the show by the American builders of machines for bicycle-making form the principal subject of the comparison, but the facts apply equally well to many other lines of work.

After describing some of the tools at the Stanley Show, and noting the many points of excellence possessed by the American machines, Mr. Horner proceeds:

"Of course one cannot suppose that American engineers and mechanics are more richly endowed with mechanical genius and skill than ourselves. But other qualifications than these are essential to success in a time like the present, when England is but one section of the world's workshop. Such qualities as these are of equal value, and, under similar conditions of mechanical skill, will turn the scale. One of these qualifications is to study the precise wants of users of machinery and tools, and to cater for those wants as carefully as possible, unhindered by preconceived ideas and conservative prejudices. This method involves not only questions of general design, but also the working out of an almost infinite number of minute details, including accessories, feeds, and movements, both for saving time and conducing to efficiency of results; details which have their highest development now in the numerous automatic machines which do everything but talk, and which are at once expeditious, accurate, and self-attending.

"The second condition is that the thought of finality must give way to that of progress. There is no machine which is so good but that it may be improved upon. If any real improvement is seen to be possible, then drawings, patterns, stamps, and special tools must be altered or re-made, so that the best possible results are secured thereby.

"The more highly developed, the more complicated, a machine becomes, the more perfect must its workmanship be. This involves the design of the most perfect machine tools and small tools for the production of this perfect work. And, inasmuch as this is only possible financially by the sale of a large number of machines, it further includes the adoption of a perfect shop system, or that under which interchangeability of parts is secured, while the actual cost of labour on any single

piece is almost infinitesimal—a fraction of a penny in some cases, in others a few pence or cents only.

"In these cardinal matters English methods and American methods differ substantially. We are conservative in method; they are alert and progressive. We tread in time-worn grooves; they seek more excellent ways. We do not adopt the interchangeable system to the same extent as they do. American shops are becoming increasingly specialized, and to a much greater extent than English ones. There are few firms in America like Messrs. Tangyes, for instance, in England, who manufacture machine tools, cranes, engines, pumps, boilers, and many other articles. The number of those who are engaged in the general machine-tools trade, like Messrs. William Sellers & Co., is not large. Many of the firms confine their attention chiefly to a few tools only. The consequence is that there is no finality in design thought of. Improvements are being constantly introduced, and the special machines, the products of particular firms, become as well known by names and numbers as the Whitworth threads or the Morse tapers."

Mr. Horner then goes on to discuss the merits and capabilities of many of the special tools at the show, the comparison in every case being wholly favorable to the American tools, and concludes by saying:

"Much more relating to the subject suggests itself to the mind, but this must suffice. These lessons of the show should be laid to heart by the great English firms, rich in capital, in prestige, in skill. In other directions there are not wanting indications that English manufacturers will be hard pressed in the near future. But one lesson is enough to learn at one time."

A Power Gas Plant.

THE improvement in gas engines, and especially in producers for the generation of power gas for use in gas motors, is a noticeable feature of current engineering progress, and we constantly hear of installations of gas producers and motors in fairly large units which generate power for industrial purposes at costs far below any figures possible with even the best steam-power plants.

A note in the *Iron and Coal Trades Review* (December 3, 1897) gives interesting information of a power gas plant recently installed at the establishment of Messrs. Porrett & Sons, at Burstall, near Leeds.

The generator used in this case was the form known as Thwaite's Continuous Cycle, which has no steam boiler, but is supplied with air from a fan driven from the main engine. The entering air is preheated by a regenerator, through which the hot gases pass on leaving the generator, about 20 per cent. of the heat in the gases being thus returned. The hot air absorbs moisture from the water in the hearth of the generator, which passes on with the air through the fuel-bed and increases the proportion of hydrogen in the gases. Several analyses of the gases under different conditions of working give average results as follows:

THWAITE'S GENERATOR GAS.

	Percentage composition by volume.		
	Coke only in generator.	Coke, with coal slack.	Coke only but dry hearth.
Carbonic acid $C O_2$	3.1	5.2	2.8
Carbonic oxide C O	28.0	24.0	28.2
Hydrogen H	5.8	7.4	4.1
Marsh gas $C H_4$	2.1	1.4	1.8
Nitrogen N	61.0	62.0	63.1
Total	100.0	100.0	100.0
Thermal value cu. ft.	132.0	116.6	125.0

The above thermal values are computed per cubic foot at 32° F., down to 212° F., in British thermal units. The volume of gas per ton of fuel was about 181,440 cubic feet, at 32° F. The thermal value of the fuel used, as determined by the Thompson calorimeter, was as follows:

	Coke.		Coal Slack.
	I	II	
British thermal units per lb.	13,850	13,889	12,913

Volatile matter, 25 per cent.

The engine in which the gas was used was built by Hartley & Petyt, and worked on the Otto cycle. There were two cylinders, each 16 by 24 inches, arranged side

by side, giving an impulse every revolution, the speed being 140 revolutions per minute, and the mean effective pressure ranging from 71 to 88 pounds per square inch.

The tests were made under ordinary working conditions, and the power varied very much, according to the demands of the machinery, ranging from a very light load up to 150 h. p. in a few revolutions. The average indicated power during the day was about 70 to 80 h. p. and the actual weight of fuel consumed amounted to only about 112 pounds per working hour, the consumption of gas ranging from 80 to 87 cubic feet per h. p. hour.

Taking the richest value for the thermal power of the gas, and assuming the higher figure for gas consumption, we have a minimum efficiency of more than 22 per cent., which is certainly a very creditable performance; and the fact that the fuel may largely consist of coal slack requires that the economy of cheap fuel also be considered in determining the commercial efficiency.

The possibilities of this method of generating power, and especially the advantage of using gas producers which will gasify the lower grades of slack without choking, cannot fail to attract the attention of all engaged in the search for cheap motive power; and, with cheap gas made from cheap fuel, used in economical motors, we may find a source of power which will compete favorably with hydraulic power, especially when first cost of plant is considered.

The Theory of the Centrifugal Pump.

THE centrifugal pump is a machine which, more perhaps than almost any other, has been constructed according to empirical methods and upon proportions determined rather by experience than from theoretical considerations. Professor Rankine, it is true, has given the subject attention, but his method has been but little used, and the leading makers in England, Messrs. Appold and Messrs. Gwynne, as well as the principal constructor in France, M. Farcot, have followed empirical lines and proportions based upon experience.

A valuable paper read December 6, before the North-East Coast Institution of Engineers and Shipbuilders, Sunderland, by Mr. C. H. Innes, gives in a very clear and practical manner the mathematical principles upon which the performance of centrifugal pumps and fans depends, and shows the action of different shapes of vanes, diffusers, and discharge pipes.

Mr. Innes calls especial attention in his paper to the theoretical discussion of the subject by Prof. Rateau, of the School of Mines at St. Etienne, and shows that with the Rateau form of vanes a high manometric power can be attained with fans, and a corresponding pressure in the case of pumps. The Rateau fan is based on the fundamental principle that maximum efficiency may be obtained by avoiding sudden changes of direction and velocity and, as far as possible, curvature of path and surface friction, and discharging the air with as low a velocity as possible.

In the Rateau fan the curvature of the vanes is so proportioned that the relative velocity of the air between the vanes either remains constant or increases slightly from inflow to outflow. The casing contains the diffuser and the volute; the diffuser increasing slightly in width from inflow to outflow, being spiral in form instead of circular, and forming a volute the cross section of which depends not only upon the angle of rotation, but also upon the number of cubic feet of air or water delivered per second.

The paper discussing this portion of the subject, while mathematical in treatment, is not at all obscure, and the correctness of the deductions is well shown by the close coincidence of the computed heads with those determined by experiment.

A table of proportions of the Rateau fans is given, by use of which the correct shape of the vanes, diffuser, and volute may be found at once for any desired capacity and for large, medium, or high pressures, and the whole paper places the data for the design of fans and centrifugal pumps within the reach of the practising engineer in a far more complete manner than heretofore.

Inland Navigation.

NOTWITHSTANDING the superlative importance of railway communication, the older and slower canal system still holds its own in many places. On the continent new canal projects are continually being reported, while in the United States the enlargement of existing canal systems is a fruitful theme for discussion.

The question of inland waterways in Great Britain has in recent years not received the attention which its importance demands, and in a leading article in *Industries and Iron* (December 3, 1897) the subject is revived and some strong points made in favor of inland navigation improvements.

Inland water transport can be made to pay, and to pay well, if a combination system is worked out on a sound basis and the traffic efficiently conducted. Even in the present imperfectly-worked systems those canals which are not dominated by railway influence are worked at a profit, and some of the old-time canals which are practically in the primitive condition that they were in when made at the end of the last century are successfully holding their own in the face of the competition of first class main-line railways equipped with every modern appliance.

This is largely due to the high cost of goods transportation in Great Britain by railway as compared with other countries, the rate per ton-mile in England being 75 per cent. higher than in Belgium and 350 per cent. higher than in the United States.

It is as an auxiliary to this quicker, but more expensive, method of transportation that a properly-organized canal service can render its best aid. Says the author of the article quoted, Mr. Perry F. Nursey: "If a systematic development of our waterways is to be undertaken, as a preliminary step the railway companies—especially those which own canals—will have to be approached, and persuaded that a system of properly-constructed canals would act as an auxiliary to their lines, and not as a competitor. It must be demonstrated to them that the two could really be working together with advantage, minerals and other heavy goods being sent by water and lighter commodities by rail."

Many of the objections now made against canal transport may be met by the introduction of improved methods. The delays due to locks can be obviated to a great extent by the use of hydraulic or pneumatic lifts, while increased speed can be secured by the installation of steam or electric propulsion.

According to the figures given by Mr. Wells, an engineer possessing an extensive acquaintance with the subject, transport by canal is much more extensively used in competing countries than in England. In the United States 27½ per cent. of the traffic is water-borne, in France 30 per cent., and in Germany 23 per cent., while in England it is less than 11 per cent.

"The present function of British canals is mainly to keep down railway rates. However useful this function may be, it falls far short of that standard of usefulness which they could be easily made to attain. They possess great possibilities which only require developing. Modified and improved in detail, they could be made to effect a reduction in the cost of carriage of heavy goods to a point far below anything which can be attempted by railways, unless, indeed, their present charges are inordinately in excess of what they should be. But, in order to secure these benefits to their fullest extent, numerous constructive details will have to be altered and the canals themselves modernised, as well as the craft plying upon them. The sectional area of the water-ways must be increased, and bridges must be widened, to allow of larger bottoms being employed than at present in use. Mechanical propulsion must be substituted for manual and horse labour, and modern facilities for the transfer of goods must be introduced. With these improved conditions, a modernised administration, and the establishment of regular services, the cost of water-conveyance could be very largely reduced. Unused canals could be made to show a good return, whilst those which now pay would pay better."

THE CONTINENTAL PRESS

Utilization of the Power of the Arc.

THE river Arc is a small stream which has its origin in the French Alps, flows as a mountain torrent through Savoy, and discharges into the Isère. Its rapid fall renders it peculiarly available for motive power, and a number of important power installations have recently been constructed at points along its banks, developing electro-chemical industries of considerable magnitude.

A general account of these works is given in *La Revue Technique* (November 25, 1897); it is worthy of attention, both from the electrical and the commercial standpoint.

The first plant of any present interest is at La Praz, where there is now a large establishment using some 3,000 h. p. for the electrical reduction of aluminum and the production of calcium carbid, and, when the works now under construction are completed, the capacity here will be increased to 13,000 h. p.

The construction of the hydraulic portion of this work is typical of the country. About two miles above the town a sort of dam is formed in the stream by some boulders, piled in the channel and permitting the water to be diverted into a basin formed in masonry, where a certain quantity can be stored, and where the sand and gravel carried by the swift torrent are deposited, instead of passing on to wear and injure the turbines. Even with this precaution much sand is carried through and the wheels hardly last longer than six months when operated continuously. The water then passes to a sheet-iron pipe 6½ feet in diameter, in which a fall of 115 feet is obtained in about a mile, with a flow of 247 cubic feet per second. The turbines are arranged on vertical shafts in units of 700 h. p., the dynamos being coupled directly to the turbine shafts. One of these generators is noteworthy from the fact that it is the largest unipolar continuous current machine yet built, having an output of 15,000 amperes, at 40 volts. At first some trouble was experienced from heating, but with proper ventilation this difficulty has been overcome, and the machine is now used with much success in electro-chemical work. At La Praz the production of aluminum is about one ton per day of the metal, either pure or in alloys. The new works, by which 10,000 h. p. is to be added to the capacity, involves the construction of a tunnel nearly a mile long, which will enable a volume of 420 cubic feet per second, with a fall of 246 feet, to be utilized.

About six miles further down the stream a contraction of the channel causes the formation of rapids, and here is placed an electro-chemical works devoted to the manufacture of chlorate of potassium, chlorate of sodium, and calcium carbid. Here about 4,000 h. p. of water is conducted through a tunnel over a mile long, and acts upon twelve turbines of 200 h. p. each, and four of 400 h. p., the wheels being arranged on horizontal axes, with generators of the Thury type mounted on the same shafts.

The production of calcium carbid here is as yet only experimental, but the electrolytic production of chlorate of potassium and of sodium by the decomposition of the respective chlorides forms an important industry, reaching over a ton per day.

Still farther down the stream the so-called Calypso works is reached, situated in a most picturesque valley between high rocky mountain walls; and here 2,500 h. p. is harnessed and utilised in the manufacture of aluminum. The output is about 2,200 pounds per day, so that it takes a little more than one horse power to produce a pound of aluminum in twenty-four hours, or as tests have shown, 309 grains (20 grams) per horse power per hour. Plans are now under consideration by which 12,000 h. p. will be utilised a short distance further down, so that before very long

nearly 32,000 h. p. will be taken from this comparatively insignificant mountain stream within a length of a few miles.

When it is considered that Upper Savoy and Switzerland contain innumerable streams of this sort, the capacity of the region of "white coal" for power generation in competition with the land of grimy collieries will be seen to be a matter worthy of respectful consideration.

River Gagings in France.

IN considering the question of river improvement and the many dependent problems, it is of the utmost importance to be able to estimate, at least within certain reasonable limits of accuracy, the volume of water to be handled, and also to have some knowledge of the maximum and minimum flow for any given case. This question is so involved with metereological and physiographical conditions that it is very difficult to establish any definite relation between the flow of a stream and the area of the basin which it drains, although many attempts have been made to do so. The best method, whenever possible, is to make careful gagings of existing conditions and use these records for cases in which, in the judgment of the experienced engineer, the relations of area, slope, and other geographical features are similar.

A very careful study has recently been made of the statistics of these points in connection with the principal rivers of France by M. Bresse, and published in the *Annales des Ponts et Chaussées* (*3e Trimestre*, 1897), and the data thus compiled, together with the theoretical discussions of the various points, form a valuable contribution to the important subject of river improvement and stream flow.

The rivers of France have been a subject of scientific observation for many years, the records for the Seine having been kept from the beginning of the present century and for other rivers for many years, and hence the statistics of high, low, and average flow are sufficiently complete to permit fairly reliable conclusions to be drawn. In connection with the measurements of the volumes of water discharged by the various rivers at different points, the area and nature of the basins drained have been studied, as well as the effects and durations of floods, so that the whole mass of data thus accumulated furnishes material of exceptional value.

In a great number of cases the volume of flow and the height of water have been measured for a sufficiently great variety of conditions to enable curves to be plotted from which the flow for any given height can be deduced at once, and in most cases these curves can be included in the parabola of the form:

$$Q = A + BH + CH^2$$

in which Q is the volume of flow; H, the height of water on the local scale; and A, B, and C are constants determined by observation.

Curves for nearly all the principal rivers of France as well as some for Belgium have been plotted, and are given in the paper of M. Bresse, and these enable valuable comparisons to be made, especially when the local surroundings of the various streams are taken into consideration.

It is impossible in this place to go into the details of the numerous gagings which M. Bresse has tabulated and discussed; for these, reference must be made to the original paper; but many of his comments will be of value in connection with gagings elsewhere. In many cases the measurements made with floats or with the Woltmann mill may be used to correct the coefficients to be used in the hydraulic formulæ which give the mean velocity in terms of a function of the slope, but these formulæ can only be relied on in cases in which the movement is of a permanent nature, or where the channel is controlled by dikes or quay walls.

M. Bazin has shown that very accurate results may be obtained by the use of weirs, when applied to small streams, but attempts to compute the flow in a similar manner for larger rivers, even when suitable dams were available, have not been equally satisfactory.

The Woltmann mill, in some of its improved forms, has the great advantage of permitting the direct measurement at

each point of the cross section of the stream, and avoids the use of a coefficient which must be more or less arbitrary. It is, however, rather inconvenient to use, especially when the current is at all strong; and the amount of time required is often an objection to its use, particularly when the level of the stream is rapidly changing.

When the level is very high or the velocity great, as at the time of floods, the only practical method is the use of floats, the time being accurately noted for a float to pass a measured distance. Surface floats offer undoubtedly the simplest means of determining the velocity of a stream, the only objection to them being the necessity of using an arbitrary coefficient representing the relation of the surface velocity to the mean velocity of the whole section. This coefficient is generally taken as 0.80, *i. e.*, the mean velocity is assumed to be equal to 80 per cent. of the surface velocity. The experiments of Bazin have shown that this value is rather too low and that it varies between 0.83 and 0.87, so that in general it should be taken as about 0.85, with but small probability of error.

Immersed floats, in the form of weighted rods, have been advocated as a means of obtaining the mean velocity directly, but it is difficult to be sure that the conditions of immersion are always such as to give the true values, and, in the opinion of M. Bresse, the error resulting from the use of such immersed floats is apt to be greater than that involved in the use of surface floats, taking the coefficient 0.85 as the ratio of the mean to the surface velocity.

In a note annexed to his report, M. Bresse describes the method used by M. Sainjon in computing the discharge during the great floods of the Loire, based on the time required for the high water to be attained at two points a known distance apart, and a comparison is made between his formulæ and those used by the Italian engineers in similar cases. The formulæ of M. Sainjon are shown to give similar results to those of Tadini, and are not greatly different from the measurements made on the Po.

The Müngsten Viaduct.

THE country around Düsseldorf is one of the busiest and most densely populated portions of Germany and contains numerous towns which are well known by their products in all parts of the world. The names of Elberfeld, Barmen, Solingen, and Remscheid, are connected with manufactures which have carried the mark "made in Germany" to many countries, and in many ways the mechanic arts have arrived at a high degree of efficiency in this part of Europe. The two towns of Solingen and Remscheid, however, have not been connected by railway except in a very indirect and roundabout manner, on account of the deep valley of the Wupper between them. The railway station at Remscheid lies over 300 feet above that at Solingen, while the level of the Wupper is more than 300 feet below the latter, and until recently the cost of bridging this valley has prevented the construction of a direct road, so that, although the distance is only five miles in an air line, the nearest way by rail has been over twenty-seven miles.

For a number of years various plans for bridging this valley have been considered, and now that the work has been accomplished the history of the whole subject, as well as a very complete account of the viaduct as constructed, is given by Herr Rieppel with many illustrations, in the *Zeitschr. des Vereines deutscher Ingenieure* (November 20, December 4 and 11, 1897).

Among the original plans submitted were included several forms of braced arch for the main span over the deepest portion of the valley; a trestle viaduct, somewhat on the American style; and a cantilever, but the design as finally adopted consists of a fine parabolic braced arch of 524 feet, 11 ins. clear span (160 meters) with trestle approaches. The clear rise of the arch from the springing of the inner chord to the under side at the crown is 225 feet, while the height of the roadbed above the surface of the Wupper is 349 feet.

The manner in which this great work was conducted offers some points of interest, and is shown very clearly in Herr Rieppel's account. No false works were

used to support the incomplete structure, the two halves of the great arch being suspended by cable work from the trestles on each side, much in the same manner as was adopted by M. Eiffel in the construction of the Garabit viaduct. A temporary trestle bridge was built across the stream at the level of the springing of the arch, and an inclined cableway conducted down each side of the valley so that material could be delivered at any point along the line of the viaduct at the surface of the ground. As the trestles increased in height the material was elevated by means of cranes, and when the projecting halves of the arch were begun the lateral tension was sustained by cables carried along the horizontal trusses and anchored in the rocky hillsides; until the ends of the arch met at the crown and the entire structure became self supporting.

The trusses for the main roadway were assembled on horizontal trestles directly beneath their respective locations and then hoisted bodily to the level of the roadway above, thus reducing the detailed work aloft to a minimum. Herr Rieppel's account shows the progress of the work in this respect very fully by means of photographs taken during the course of construction, forming an excellent record of the manner in which the viaduct was constructed.

The main arch was constructed without hinges, the springings also forming a portion of the bases of the main trestles; but the main roadway trusses were placed entirely above the arch truss, the bottom chord of the road truss being on the same level as the upper rib of the arch. Notwithstanding the magnitude of the work the whole effect of the completed viaduct is most graceful and artistic, the work enhancing rather than defacing the beautiful scenery with which it is surrounded.

The completed viaduct was subjected to a thorough test by a load consisting of three of the heaviest freight engines and forty loaded cars. The greatest deflection measured was a trifle over 15 millimeters, and there was not the slightest indication of any permanent set.

Pompeian Restorations.

THE remains of Roman architecture which have been partially preserved for us at Pompeii have been the subject of much study and discussion, but it is probable that no such systematic attempt has been made to restore the architecture of the buried and exhumed city as that recently completed by the Leipzig architect, Professor Weichhardt. For a full account of the work which he has done in this interesting historical and architectural field, reference must be had to the magnificent volume recently published, but a very fair idea of the manner in which the city as it existed before the fatal eruption has been restored by Prof. Weichhardt, may be obtained from the extracts from his book published in various journals, of which accounts we may cite, as most complete, that appearing in the *Schweizerische Bauzeitung* (November 20, 27, December 4, 11, 1897).

In order to make an intelligent restoration of these ruined buildings something more than a mere familiarity with Greek and Roman architecture is necessary, since the judgment of the trained archæologist is often necessary in order to determine from the broken capital or the nature of the intercolumniation just what period or style was possessed by the temple or building of which only the brick core and a few fragments of the exterior finish now remain. There is often a kind of instinctive genius in this sort of work, which enables the enthusiastic archæologist to feel as it were the spirit of the original constructor, and to proceed with his work with much the same certainty as a Cuvier or Owen in the restoration of a mammal from a tooth, or of an Agassiz in the reconstruction of a fish from a few scales.

Professor Weichhardt has certainly done his work well, as any student of architecture will realize when he compares the drawings of the existing remains with the restorations of the same buildings as shown in the illustrations of the articles to which reference has been made.

The views of the Triangular Forum, with its ancient Greek temple; of the

Temple of Jupiter and the Public Forum; and especially of the very effective drawing of the restoration of the Temple of Augusta Fortuna; all these show the spirit of the artist-archæologist in a manner which must be seen to be fully appreciated.

It is in painstaking work of this kind that the industrious attention to minute detail which is so characteristic of the German specialist shows to the best advantage. It is at Pompeii that we have the best record of ancient architecture down to the beginning of our era, uncontaminated with any of the later debasements which so soon began to creep in, and it is in such work as Professor Weichhardt has given us that we may find the best interpretation of the remains which are left to us.

The Strength of Wire Rope.

A VERY exhaustive series of investigations into the resistance of wires and wire rope, both as regards tension loads, and bending action, has been made at the government testing-laboratory at Berlin, by Professor Rudeloff, and the results have been incorporated in a valuable double number of the *Mitt. aus den Kgl. technischen Versuchsanstalten* recently published (Parts III and IV, 1897).

The work contains a careful discussion of the subject, and the reputation of the author lends added value to the new data thus placed on record. A large portion of the paper consists of tabulated records of experiments, which must be consulted to be appreciated, but there are some portions of the report which can be reviewed in general terms, and which may serve to give an idea of the remainder.

The tests were intended to investigate the resistance both of single wires and of the same wires twisted into rope. For the tests of single wires a special machine of one-ton capacity was constructed by Prof. Rudeloff, while for the wire ropes the fine 50-ton testing machine of Prof. Martens was used. The tension loads were increased successively, and the extensions measured within 0.1 mm.; the test length being 300 mm. As the stretch ceased to be proportional to the increase of load, the elastic limit was noted, and the breaking load was then determined within a probable error of 2 kilograms for the single wires, and 5 kilograms for the wire ropes.

The device for measuring the resistance of the wires to repeated bending under various loads was a simple apparatus, the weight being suspended directly to the end of the wire, and the latter passing up between two cheeks, the ends of which were finished to the desired radius of curvature, the cheeks being rocked mechanically. The apparatus permitted six wires to be tested simultaneously, and the whole mechanism was constructed in the workshop of the laboratory for these especial tests. In this device tests were made showing the influence of changes in load upon the number of bendings before breakage occurred, the radius of curvature of the bend remaining constant. Tests also were made with constant loads and varying radii of curvature, and these two series are of especial value in connection with the use of wire for hoisting and power transmission.

The results of these tests are plotted, not only in the usual form of curves in plane co-ordinates, but also in solid models, showing as in three dimensions the relations of load, radius of curvature, and life in number of bends. For the detailed account of this portion of the work the original paper must be consulted but in general the following deductions were made:

The endurance of wires under repeated bending over a uniform radius of curvature diminishes rapidly with the increase of load up to loads of about 6,000 pounds per square inch, but for further increase of load the reduction in endurance proceeds more and more slowly.

The endurance under repeated bending from increasing loads, diminishes the more rapidly the less the resistance and the greater the extensibility of the material.

The influence of increasing radius of bending upon the endurance was rapid at first, but showed a continually-diminishing importance above 50 diameters of the wire.

These tests, as well as the tests of wire ropes, were made upon wires of various strengths, in order to obtain a progressive series of points through which curves could be drawn.

The tests with the ropes were made upon the materials used for the single wires, so that a series of relations between a given wire and a rope made from the same wire were established. In some instances the strength of a rope per unit of cross-section was greater than that of the single wires of which it was composed, but in others it was much less, depending upon the material and the conditions of test.

This important work was undertaken especially to furnish data for the use of wire rope in connection with the mining industry of Germany, but will doubtless be welcomed by users and makers of wire and wire rope in all countries.

A New Railway Station in Paris.

THE Quai d'Orsay will be remembered by all the visitors to the Paris Exposition of 1889 as a sort of connecting link between the main buildings on the Champ de Mars and those on the Esplanade des Invalides, and on this portion of the river front a number of important and interesting exhibits were then placed. It is now proposed to bring the line of the Orleans railway into the city by means of a subway as far as the Quai d'Orsay, and there to build a new passenger station which shall not only greatly increase the capacity for handling traffic, but also be an ornament to what is already one of the most beautiful portions of Paris.

Accounts of this important engineering and architectural work appear in several of the technical journals, and from *Le Génie Civil* (December 11, 1897) and *La Revue Technique* (November 25, 1897) we make extracts.

At the present time the Orleans railway enters Paris as far as the Pont d'Austerlitz, a short distance above the island of the Cité, and a large station, the *gare d'Austerlitz-Orleans*, is situated there, on the left bank of the Seine. It is now proposed to carry the line of the railway on the left bank through a subway as far as the Quai d'Orsay, and on the site of the former palace of the *Cour des Comptes*, the blackened ruins of which have remained since 1870 to mark the doings of the Commune, a new station is to be erected.

There has been much discussion in Paris as to the possibility of designing a railway station which shall not injure by comparison the fine architectural structures which, both historically and artistically, add so much to this locality. In order to obtain the best results, a schematic plan has been prepared by the railway company, including all the essential points so far as the operation of the work of the station is concerned, and three comparative designs have been made by as many well-known architects for the details and façade. The designs have been submitted to a commission of experts, and the plans are now published with sketch elevations in the *Génie Civil*.

The general appearance of the various designs is affected mainly by the fact that the architects were commissioned to prepare plans respectively for a station without a hotel, a station with a hotel as a secondary attachment, and a station with a grand hotel. While the addition of a hotel to the buildings of the terminal proper gives the architect increased opportunity for decorative treatment, yet, in the opinion of M. Laloux, one of the architects, it is not a matter of real importance, since in this location there is small probability of the building being used for anything but minor transient accommodations, surrounded as the station will be by the great hotels of Paris.

The plans all show the offices, waiting-rooms, and other buildings placed by the side of the train shed,—not arranged in the form of a "head house," as is sometimes the case,—and as the tracks are below the surface, passengers will thus be enabled to descend between any lines of rails without crossing the tracks. The train shed will be about 130 feet span, with six tracks under this width, and six more under the remainder of the structure, providing both for through and local traffic in a very convenient manner. Judging from the appearance of the proposed plans, any of

them would be considered ornamental in other locations, and even on the proposed site will not, in our opinion, detract from the dignity of the surroundings.

The subway by means of which the tracks are to be conducted from the *gare d'Austerlitz* will be a difficult piece of construction for several reasons. Passing as it will under the quay along the bank of the Seine, its tunnel will cut through the shore abutments of a number of the finest bridges of Paris, but every precaution has been taken in the design to provide for the reinforcement of the masonry at the necessary points, the cross-section of the tunnel being made elliptical with a complete masonry ring to resist horizontal pressure to the best advantage. Between the bridge piers the subway is planned to be partially open on the side toward the river, the quay pavement above being supported by posts and girders, and heavy retaining walls sustaining the lateral pressure on both sides.

Much solicitude has been expressed as to the fate of the numerous trees with which the river front is lined, and a special report has been made upon this subject. According to this investigation it will be possible to save a large number of the trees, and, as many of those to be sacrificed are claimed to be not worth saving, the beauty of the city will suffer but little in this respect.

The completion of this important work will give Paris what has long been needed, —rapid subway transit to the heart of the city, as well as increased main line accommodation,—and, in addition, will do much to assist in providing for the flood of travel expected in the exposition year.

Antique Copper Tools.

ANTIQUARIAN researches are not always of technical interest, but, when a scientist of the reputation of M. Berthelot takes the trouble to investigate the composition and physical properties of metallic tools which are of authentic antiquity, it may be worth while to examine with him the materials with which the ancient Egyptians and their contemporaries did their work and killed each other. M. Berthelot has contributed a very interesting article upon this subject to the *Annales de Chimie et de Physique*, from which we make extracts.

The ages of the specimens examined by M. Berthelot were in some cases established by inscriptions on the articles themselves; this being the case especially with the case of the sceptre of Pépi I, of Egypt, and of the lance of the king of Kish, at Tello. In other instances the dates were determined approximately from the character of other articles contained in the tombs in which they were found; care being taken not to confound genuine antiques with tools left by later hands, such as are often found in cases where mediæval violators and treasure-seekers have rifled the ancient burial-places. While some of the articles were undoubtedly intended solely for ornament, and some for military weapons, others were evidently designed for tools, and, as such, possess an interest to engineers, both from their form and from their composition. Among these one of the most interesting is a small chisel, found in the necropolis of Toukh, in Egypt. This tool is now about 80 mm. long, but was originally somewhat longer, the upper portion showing a broken end. The body is 4 mm. wide by 2 mm. thick, and the lower end is flattened out into a cutting edge of about 6 mm. in width, by scarcely ½ mm. in thickness. Although much oxidised and covered with verdigris, the composition of this little tool is shown by M. Berthelot to consist entirely of pure copper, without a trace of tin. Similar results were obtained by analysis of a number of other articles, including needles, spears, a hatchet, etc., and there is every reason to believe that these tools and weapons were composed, not of a bronze or other alloy, but of pure copper, corresponding in all respects to the metal we are familiar with to-day.

Because of the oxidised and crumbling condition in which these tools are found to-day, no conclusions can be drawn as to their original temper or hardness, but, unless they were so hardened as to retain their cutting edges, it is difficult to see how they could have served the purposes

for which they evidently were designed. These examples, however, show at least that any temper which the ancient tools possessed was not due to any especial alloy or composition of various metals, and that, if any hardening process was known to the ancient Egyptians it must have been one which was applied to the pure copper itself.

Slag as a Material of Construction.

VARIOUS attempts have been made to utilize blast-furnace slag as a material of construction, but usually without permanent success. The hygroscopic nature of the material renders it perishable and crumbling when exposed to the action of the atmosphere, thus rendering it unsuitable for paving, while the glassy impermeability unfits it for many uses to which bricks are now applied. Of late certain slags have been found suitable for the manufacture of cement, and we have already noticed this method of using slag in the arts. A similar application is found in the production of artificial stone, and the objectionable features of the primitive article seem to have been overcome by the use of the granulated slag, cemented into a mass in one or the other of several ways and moulded into any required form by pressure.

An article by Herr Lürmann, in *Stahl und Eisen* (December 1, 1897) gives a very full account of the extensive manufacture and use of this material in Germany, together with a set of plans for buildings and machinery suitable for the production of bricks of slag.

The granulation of the slag is effected by discharging it, in the molten condition, as it flows from the furnace, into a tank of water, in a manner similar to that used in the preparation of slag cement. The water in the tank becomes opalescent by solution of a portion of siliceous acid, and this soluble siliceous acid, after a short time, binds the whole mass together, especially if pressure be applied. This cementing is more effectively accomplished if a portion of finely-ground slag be used in connection with the coarser granulated material, although a somewhat longer time is required for the mass to become hard. The time required for hardening may be reduced to six or eight days, if about ten per cent. of slaked lime be mixed with the slag, the combined action of cement and mortar thus being effected.

This method of utilizing slag is by no means new, having been used by Langen as long ago as 1862; and an official report of that date states that test specimens made with one part of lime to five parts of granulated slag showed nearly 60 per cent. of the compressive resistance possessed by neat Portland cement.

At first the material was compressed into bricks by use of a simple form of hand press, constructed on the toggle-joint principle; three men turning out about one thousand bricks per day of ten hours. This method, however, was defective, owing to the insufficient degree of pressure attained, and the product was unsatisfactory, being too porous and fragile.

The introduction of power presses has entirely remedied this difficulty, and at the present time brick-making plants, using slag as material, are adjuncts to many of the German blast furnaces.

The bricks, as usually made, are in the standard German proportions of 250 × 120 × 65 millimeters, resembling a light sandstone in appearance, and have clean, smooth surfaces and sharp angles. They are best laid with very thin mortar joints, and their use shows a noteworthy economy of mortar, for this reason. The strength of these bricks is not greatly different from those of ordinary burned clay. A safe working-load may be taken at about 200 pounds per square inch, the crushing strength being about 1,500 pounds per square inch. The resistance to the action of heat is excellent, and they are satisfactorily used for chimney and flue construction.

The plant described in Herr Lürmann's paper is intended for a capacity of 8,000 bricks per day, and involves an original outlay of 40,000 marks (£2,000 or $10,000), and the estimated cost of operation, including interest and depreciation, brings the cost of the bricks to about 12 marks (12 shillings or $3.00) per thousand.

THE ENGINEERING INDEX

INTRODUCTORY

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American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met Soc of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.

Elekt rotechniker. *b-m.* Vienna
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* New York.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Magazine. *m.* London & New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Fortnightly Review. *m.* London.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Garden and Forest. *w.* New York.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash , D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mitt. aus d. Kgl. Tech Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Science Review. *qr.* New York.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue Technique. *b-m.* Paris.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, Ohio,
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J
Stone. *m.* Chicago, Ill
Street Railway Journal. *m.* New York
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschfift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Bath Buildings.

The Wentworth Avenue Free Baths, Chicago. Description and plans of the largest public bath house yet established in this country, having a capacity of nearly 100 baths an hour. 1700 w. Eng Rec—Dec. 11, 1897. No. 17116.

Building Construction.

Building Construction in Relation to the Public Health. Peter Fyfe. Principally confined to the work of the carpenter and joiner, discussing how the leading principles of sanitation should be applied. Also editorial. 7000 w. San Rec—Dec. 10, 1897. No. 17191 A.

Cement Plaster.

The Technology of Cement Plaster. Paul Wilkinson. Gives the history of the discovery of the product bearing this name, and explains the process of preparing the material for use. 3700 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16954 D.

Competition.

Prize Designs for Business and Apartment Buildings in Vienna. (Die Preisausscheibung für den Umbau des Hauses, I. Kärntnerstrasse Nr. 24, in Wien.) Examples of modern Viennese architecture, with plans and elevations. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 3, 1897. No. 17341 B.

Construction.

Important Problems in Construction. William W. Crehore. Considers wooden construction and load distribution. Ill. 1600 w. Br Build—Dec., 1897. No. 17292 C.

Eiffel Tower.

The Stability of the Eiffel Tower. (Sur la Stabilité de la Tour Eiffel.) A report upon the movements of the tower, due to the action of the wind, of solar heat etc. A daily period was found, but no appreciable displacement of the apex during the year 1896-97. 1000 w. Comptes Rendus—Dec. 6, 1897. No. 17323 D.

Exposition.

The Exposition of 1900. (Exposition de 1900.) A review of the present condition of the work on the Champs-Elysées and the Champ-de-Mars. 2000 w. Le Génie Moderne—Nov. 15, 1897. No. 17313 B.

The Paris Exhibition of 1900. An account of preparations being made by the removal of buildings and the contracting for the new structures. 2000 w. Engng—Dec. 3, 1897. No. 17117 A.

The Prize Design for the Vienna Pavilion. (Die Preisausschreibung für den Pavillon der Stadt Wien.) With illustrations of the first, second, and third prize designs for the city pavilion for the jubilee exposition to be held at Vienna in 1898. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 12, 1897. No. 17338 B.

The Sites of the Exposition of 1900. (Les Emplacements de l'Exposition de 1900.) An historical account of the portions of Paris which are to be used for the exposition, with plans at various periods from 1609. An interesting account of a part of old Paris. Serial. Part I. Le Génie Moderne—Nov. 15, 1897. No. 17314 B.

Fire Dangers.

Warehouse and Factory Fire Dangers. George H. Bibby. Discusses the construction of these buildings and the causes of the spread of fires within the buildings. 2000 w. Arch, Lond—Dec. 3, 1897. No. 17131 A.

Foundations.

Some Details of Pneumatic Foundation Work. Illustrated description of the foundations of the Empire Building, corner of Rector street and Broadway, New York. 1300 w. Eng Rec—Dec. 11, 1897. No. 17111.

Library.

New York's New Public Library. Edwin Emerson, Jr. Illustrations of the outside of the building with some remarks on special features of the accepted design. 1200 w. Harper's Wk—Dec. 11, 1897. No. 17062.

The New York Public Library. Description with illustrations and general information. 1600 w. Eng Rec—Dec. 11, 1897. No. 17115.

McEwan Hall.

McEwan Hall, Edinburgh University. R. A. Illustrations, plan and general description of a beautiful building recently opened. 1500 w. Builder—Dec. 11, 1897. No. 17224 A.

Municipal Buildings.

The New Municipal Buildings, Toronto. A résumé of the plans and specifications as finally adopted for the heating, plumbing, ventilation, gas and electric wiring. 2800 w. Can Arch—Dec., 1897. No. 17440 C.

Pompeii.

Pompeii before the Destruction. (Pompeji vor der Zerstörung.) A review of Weichhardt's recent work, with a number of reproductions of his restorations of the temples and other buildings. A valuable contribution to architecture and archæology. Four articles, three plates. 5000 w. Schweizerische Bauzeitung—Nov. 20, 27, Dec. 4, 11, 1897. No. 17367 H.

Schools.

The Planning of High and Endowed Schools for Girls. F. J. Osborne Smith. Read at meeting of the Architectural Association, London. Considers the types of plans which experience has proved to be best suited for the work. Also the fittings for cloak-rooms, lavatories, &c. 5500 w. Arch, Lond—Dec. 10, 1897. No. 17209 A.

The Roman Catholic Protectory of Philadelphia, Pa. Illustration of the building and the mechanical plant for heating and ventilating. 2500 w. Eng Rec—Dec. 18, 1897. No. 17189.

Stone-Cutting.

Practical Stone-Cutting. Charles H. Fox. Part first is introductory to a description of methods claiming to be superior to those usually

employed. 3800 w. Stone—Dec., 1897. Serial. 1st part. No. 17286 C.

HEATING AND VENTILATION.

Conservatory.

The Warming and Ventilating of the Horticultural Buildings at the Hamburg Exposition. (Heiz und Luftwesen auf der Gartenbauausstell ung in Hamburg.) With full details of the hot water system of these important buildings especially intended as a model plant. 3500 w. Zeitscher d Ver Deutscher Ing—Nov. 27, 1897. No. 17333 D.

Heating Installations.

Installation of Successful Heating Systems. Reviews the information necessary to decide upon the best system; discusses various systems and matters relating to their installation. 2000 w. Dom Engng—Dec., 1897. No. 17271 C.

House Heating.

European Systems of House Heating. J. L. Saunders. Comparing British and American methods, and noting differences due to climatic conditions. The British house-heating practice is growing more and more like American. 2500 w. Engineering Magazine—Jan., 1898. No. 17399 B.

Humidity.

The Humidity of the Air. (Der Feuchtigkeitsgehalt der Luft.) Bruno Griep. Discusses the question in connection with house heating, and maintains that for health the humidity should be maintained the same as exists with the corresponding temperature in summer. 2000 w. Gesundheits Ingenieur. Nov. 15, 1897. No. 17361 B.

School Houses.

Automatic Heat Control in School-House Ventilation. Illustrated description of an interesting arrangement used in the school building, corner of Carson and Tenth streets, in Pittsburg, Pa. 3000 w. Eng Rec—Dec. 4, 1897. No. 17041.

Ventilating System.

A Ventilating System in Connection with a Furnace. Detailed description of a system in operation during last winter in the residence of J. P. Watson, Flatbush, N. Y., used in connection with a Thatcher furnace. 2000 w. Met Work—Dec. 18, 1897. No. 17181.

LANDSCAPE GARDENING.

Park Protection.

Landscape Gardening. Editorial on the aims of this art, and on the dangers threatening the parks of New York. 2000 w. Gar & For—Dec. 22, 1897. No. 17246.

Parks.

Park-Making. Editorial suggestions and criticisms. 1000 w. Gar & For—Dec. 15, 1897. No. 17157.

Villa Lante.

The Garden of Villa Lante. Harold Van Buren Magonigle. Illustrated description of this lovely formal garden of Italy. 1300 w. Am Arch—Dec. 25, 1897. No. 17291.

PLUMBING AND GASFITTING.

Drain Ventilation.

The Sanitary Arrangements of the Public Offices at Dauba, Bohemia. (Ueber die Einrichtung der Abortanlage in dem Amtsgebäude zu Dauba.) The ventilating pipes from the closets are connected to a flue in the chimney, thus causing a constant and powerful ventilation. 2000 w. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1897. No. 17359 D.

Inspection.

Duties of a Plumbing Inspector. Henry Sieben. Discusses the duties and gives the Kansas City methods. 1200 w. Dom Engng—Dec., 1897. No. 17267 C.

Regulations.

Plumbing Regulations and Their Practical Application. W. F. Taaffe. A résumé of the code of the New York Building Department, with explanations. 1800 w. San Plumb—Dec. 15, 1897. Serial. 1st part. No. 17197.

The Regulation of Plumbers' Work. Thomas S. Ainge. Remarks on this subject suggested by a bill presented to the Legislature of the State of Michigan. States briefly the existing laws, giving reasons why they are necessary. 2800 w. Dom Engng—Dec., 1897. No. 17269 C.

MISCELLANY.

Address.

Presidential Address before the Society of Architects, London. T. Walter L. Emden. Considers the profession, sanitation, art, and the drawbacks to the profession. 3800 w. Arch, Lond—Dec. 3, 1897. No. 17132 A.

Fireproofing.

A Competitive Test of a Hollow Tile and a Concrete Fireproof Floor. Describes an arranged test growing out of a challenge by Henry Maurer & Sons, of New York, manufacturers of hollow tile fireproofing, and responded to by the firm of John A. Roebling's Sons Co. Ill. 1500 w. Eng News—Dec. 2, 1897. No. 16992.

Fire Protection.

Protection Against Fire in Museums. Report on English museums as discussed by the Select Committee on Museums, of the Science and Art Department. 5700 w. Arch, Lond—Nov. 26, 1897. No. 16996 A.

History.

The History of Architecture. Prof. Aitchison. Abstracts of four lectures on this subject, delivered in the Alexandra College, Dublin. 3500 w. Arch, Lond—Dec. 3, 1897. No. 17133 A.

Malta.

Notes on Renaissance Architecture in Malta, with Special Reference to the Buildings of the Order of St. John. Arthur S. Flower. A very interesting paper, giving an account of the beautiful architecture of the island, and much information. Discussion. Ill. 12000 w. Jour of Roy Inst of Brit Archs—Nov. 20, 1897. No. 17215 D.

Medieval Architecture.

Norman Gothic or Medieval Architecture. Cyrus K. Porter. A general outline of the subject confined to a study of its development in Great Britain. 6800 w. Stone—Dec., 1897. No. 17287 C.

Mural Painting.

Frank D. Millet's Mural Painting for Pittsburg. Charles H. Caffin. An interesting description of the painting for the main hall of the Bank of Agriculture. Ill. 1000 w. Harper's Wk—Dec. 25, 1897. No. 17243.

Tenements.

Improved Tenement Homes for American Cities. Gustavus A. Weber. Considers the needs of this class, discussing the conditions in various cities, and giving suggestions for general application. 6500 w. Munic Affairs—Dec., 1897. No. 17450 C.

Newcastle, Eng.

A Review of Newcastle Architecture. Frank W. Rich. A short but interesting review of the progress of architecture during the present reign, taken from the inaugural address before the Northern Architectural Assn. 2200 w. Builder—Nov. 20, 1897. No. 16927 A.

U. S. Capitol.

The United States Capitol Building, and the Architects of the Capitol. Historical account of the building, with views and features of special interest, and biographical accounts of the architects connected with the work. 3800 w. Arch & Build—Dec. 4, 1897. No. 17030.

Woodwork.

The Treatment and Decoration of Woodwork. Walter J. Pearce. Many suggestions, and criticisms of prevailing practice. Ill. 2500 w. Plumb & Dec—Dec. 1, 1897. No. 17153 A.

CIVIL ENGINEERING.

BRIDGES.

Arch.

Influence Lines for Rigid Framed Arches. (Einflusslinien des Gelenklosen Bogens.) A graphical discussion of the rigid braced arch, showing the positions of the possible lines of pressure. Three articles. 5000 w. Schweizerische Bauzeitung—Nov. 6, 13, 27, 1897. No. 17366 E.

Channel.

A New Scheme for Crossing the Channel. (Un Nouveau Mode de Traversée du Pas de Calais.) The plan involves the construction of a submarine railway bridge similar to that used at St. Malo, carrying rolling "ferry-boats," with chain haulage. 2500 w. Le Génie Moderne—Dec. 1, 1897. No. 17315 B.

Chicago Canal.

Proposed Bridges Across the Chicago Drainage Channel. Extracts from the specifications, with drawings and general information. 4200 w. R R Gaz—Dec. 3, 1897. No. 16967.

Cornhouse Bridge.

The Cornhouse Bridge at Berne, Switzerland. Elmer L. Corthell. The article is supplemental to one published in this paper in issue of Dec. 19, 1895, giving illustrated description of special features of this bridge now nearing completion. 2000 w. Eng News—Dec. 16, 1897. No. 17176.

Drawbridges.

Railway Drawbridges Over the Chicago Drainage Canal. Describes four of the five railway bridges crossing this channel, giving specifications and illustrations. 5000 w. Eng News—Dec. 2, 1897. No. 16991.

Floating Bridge.

Carriage and Passenger Floating Bridge. Illustrated description of a bridge built for the Southampton and Itchen Floating Bridge and Roads Company, which has proved an advance in general efficiency and economy. 1100 w. Engng—Nov. 26, 1897. No. 17008 A.

Lifting Bridge.

Lifting Bridge Over the Murray River at Swan Hill. This river is the natural boundary between New South Wales and Victoria, and bridges over it are erected at the joint expense of the two colonies. Illustrated detailed description. 1000 w. Engr, Lond—Nov. 19, 1897. No. 16918 A.

Loads.

Suddenly Imposed Loads. Editorial discussion of what constitutes a suddenly imposed load, and the action of live loads. 1600 w. Engr, Lond—Nov. 26, 1897. No. 17020 A.

North River.

Bridging the North River. Walter H. Knight. A letter to the editor explaining why the writer considers a tunnel under the North River at New York the much more feasible plan. 1000 w. R R Gaz—Dec. 10, 1897. No. 17090.

Paint Tests.

Paint Tests. Discussion by W. J. Wilgus of paper by Max Toltz, with the practice favored by the writer. 1000 w. Jour Assn Engng Socs—Nov., 1897. No. 17285 C.

Swing Bridge.

Lifting a Chicago Swing Bridge. Explains how the repairs of the Randolph street bridge, in Chicago, were carried out. 600 w. Eng Rec—Dec. 11, 1897. No. 17112.

Double-Track Electric-Railway Viaduct for St. Louis and Suburban Ry. at Edgebrook, Mo. Illustrates and describes a steel structure recently erected about eight miles from St. Louis, Mo. 1200 w. Eng News—Dec. 23, 1897. No. 17255.

Viaduct.

The Müngsten Viaduct. (Die Thalbrücke bei Müngsten.) A fully illustrated account of this fine viaduct at Müngsten, near Düsseldorf; the great arch is 525 feet span, and the total length 1640 feet. Three articles. Four plates. 12000 w. Zeitschr d Ver Deutscher Ing—Nov. 20 Dec. 4, 11, 1897. No. 17329 H.

CANALS, RIVERS AND HARBORS.

Baltic Canal.

The Influence of the Kaiser-Wilhelm Canal upon the Port of Hamburg. (Die Einwirkung des Kaiser Wilhelm Canals auf die Seeschiffahrtsstellung Hamburgs.) Showing that Hamburg has been benefitted rather than injured by the opening of the canal between the North Sea and the Baltic. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—Dec , 1897. No. 17358 D.

Bulkhead.

The New Delaware River Bulkhead at Philadelphia, Pa. Describes the method of work contemplated, giving illustrations. 900 w. Eng News—Dec. 9, 1897. No. 17070.

Coast Improvement.

The Control and Fixation of Shifting Sands. John Gifford. Proper forestry cultivation will convert shifting sands into fixed soil and enable large areas to be reclaimed. Many valuable and interesting instances are given. 4000 w. Engineering Magazine—Jan., 1898. No. 17396 B.

Chicago Canal.

The Status of Work on the Chicago Drainage Canal. Abstract of message of the new president, William Boldenwick, reviewing progress of the work and outlining works yet to be executed. 2000 w. Eng News—Dec. 23, 1897. No. 17254.

Danube.

The Regulation of the Rivers of Hungary. (Ueber die Flussregulierungen in Ungarn.) Discussing principally the improvements in the middle Danube between Duna-Radvány and Báziás. 5000 w. 1 map. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1897. No. 17357 D.

Docks.

Extension of the Liverpool Docks. Information of the extensions and improvements now in progress and in contemplation, with description of the docks, port and harbor. 3300 w. Cons Repts—Jan., 1898. No. 17281 D.

Repairing the Leak at Dry Dock No. 3, Brooklyn Navy Yard. Illustrated description of this difficult piece of engineering work now in progress. 1700 w. Sci Am—Dec. 25, 1897. No. 17261.

The New Concrete and Steel Government Docks at Puerto Cabello, Venezuela. Brief illustrated description of a rather novel construction. 700 w. Eng News—Dec. 23, 1897. No. 17257.

Drainage.

The Drainage of Lake Fucino. (Die Trockenlegung des Fuciner Sees.) An account of the completion of the recovery of 35,000 acres by the drainage of Lake Fucino, in Italy, by Prince Torlonia. The total cost of the work was $8,300,000. Two articles, 5000 w. Deutsche Bauzeitung—Nov. 27, Dec. 4, 1897. No. 17890 E.

Gaging.

A Study of Gaging Statistics. (Etude sur la Statistique des Jaugeages.) M. Bresse. Giving a very full résumé of the measurements of flow of the principal rivers of France under various conditions, considered in connection with the basins which they drain. 20,000 w, 5 plates. Ann des Ponts et Chaussées, Part III. 1897. No. 17344 F + G.

Lighthouses.

Lighthouses and Light-Vessels. Discussion of the fifth and final report of the Royal Commission on Electrical Communication with lighthouses. 2500 w. Elec Rev, Lond—Dec. 5, 1897. Serial. 1st part. No. 17120 A.

Marseilles.

Enlargement of the Port of Marseilles. (Agrandissement du Port de Marseille.) With plan of the present condition of the harbor, and an account of the proposed docks, with section of the new breakwater. 1200 w. Le Génie Civil—Nov. 20, 1897. No. 17304 D.

Enlargement of the Port of Marseilles, France. From *La Nature*. Explains the reasons that prompted the work, and the conditions under which it is being executed. Ill. 1600 w. Sci Am Sup—Dec. 25, 1897. No. 17266.

Nicaragua Canal.

The Dream of Navigators. A. S. Crowninshield. Showing the value and importance of the Nicaragua Canal and urging its construction under the auspices of the United States Government. 2800 w. N Am Rev—Dec., 1897. No. 16949 D.

Pile-Driving.

Pile-Drivers and Pile-Driving. Perry F. Nursey. A consideration of this subject showing why a heavy ram with a short fall does the most efficient work. 2000 w. Ind & Ir—Dec. 17, 1897. No. 17454 A.

Plymouth, Eng.

Harbor Extension at Plymouth. Recommendations from the report of J. Wolfe Barry and Cuthbert Brereton to the Corporation of Plymouth, in reply to the points submitted for their consideration relative to the advisability of making this extension. 1300 w. Transport—Nov. 26, 1897. No. 17005 A.

Ship Canals.

Some Early Ship Canals. A review of the various schemes projected in England. 1100 w. Engr, Lond—Nov. 26, 1897. No. 17019 A.

The Lake Erie and Ohio River Ship Canal. Information from the report of the provisional committee of the Pittsburg Chamber of Commerce. Gives argument for the building of this canal, route proposed, summary of estimates of cost, &c. 1200 w. Eng News—Dec. 23, 1897. No. 17256.

The Race to the Atlantic Seaboard between Canada and the United States. Editorial discussion of the projects being considered to connect the Great Lakes with the sea. 2000 w. Transport—Nov. 19, 1897. No. 16934 A.

Surveying.

Hydrographic Surveying—How the Maps and Charts of our Coast and Harbors are Made. Thomas C. Harris. A brief explanation of the work done in American waterways, by the government engineers, to insure safe passage through harbors. Ill. 2000 w. Sci Am—Jan. 1, 1898. No. 17463.

Towing.

See Electrical Engineering. Power.

IRRIGATION.

Corona, California.

Pipe Line No. 2 and the Lands Irrigated under it at Corona, Riverside Co., Cal. H. Clay Kellogg. Gives the source of the supply, materials used, the engineering work, &c. 3000 w. Jour Assn of Engng Socs—Nov., 1897. No. 17284 C.

Cyprus.

Irrigation Works in Cyprus. Discussion of the work about to be undertaken to store up the supply of water for irrigation of the plains during the dry season. 1200 w. Engr, Lond—Nov. 26, 1897. No. 17018 A.

Drainage.

Dimensions of Channels for Surface Drainage. Charles Edward Livesey. From Proceedings of Institution of Civil Engineers, (England) Vol. CXXVIII. Statement of theory and description of its application in the construction of irrigation works in India. 2800 w. Jour W Soc of Engs—Oct., 1897. No. 17088 D.

India.

Indian Droughts and Irrigation. Reviews the improvements that have been made in India, the present conditions, and remedies needed. 2000 w. Nov. 15, 1897. No. 16929 A.

Madras, India.

Schemes for Extending Irrigation. W. Hughes. Note presenting a few schemes likely to be of use in preventing famine. 700 w. Ind Engng—Nov. 6, 1897. No. 17066 D.

Madura, India.

The Diversion of the Periyar. John Pennycuick. Abstract from Proceedings of the Institution of Civil Engineers (England) Vol.. CXXVIII. An account of work in India for the irrigation of the Madura district. 1700 w. Jour W Soc of Engs—Oct., 1897. No. 17087 D.

MISCELLANY.

Artificial Stone.

The Manufacture of Building Stone from Granulated Slag. (Mauersteine aus Granulirten Schlacken.) Describing a plant for making artificial stone from blast furnace slag. The granulated slag is mixed with lime mortar and compressed into blocks. A number of such plants are in successful operation in Germany. 4500 w. 1 plate. Stahl und Eisen—Dec. 1, 1897. No. 17350 D.

Cement.

Cement Tests in the Year 1896-1897. (Cementuntersuchungen aus dem Betriebsjahre 1896-1897.) Official report of the tests made in the Royal Testing Laboratory at Berlin, with many tables of data and results of the work of the past fiscal year. 15000 w. Mittaus d Kgl Tech Versuchsanstalt—Part V. 1897. No. 17377 F.

New Portland Cement Plant of the Coplay Cement Company. Frederick H. Lewis. An illustrated description of a plant producing 500 bbls. daily. The latest types of kilns and mills are used, and both processes and machinery are explained. 3000 w. Eng Rec—Dec. 18, 1897. No. 17184.

The Portland Cement works at Volsk, on the Volga. (Die Portlandzementfabrik Wolsk a. d. Wolga.) With plans, sections and elevation of the large buildings, and an account of the plant. The output is 300,000 barrels, of 375 pounds each, per year. 1500 w. Zeitschr d Ver Deutscher Ing—Nov. 27, 1897. No. 17332 D.

Concrete.

Computations for Floors and Beams in Reinforced Cement. (Du Calcul des Planchers et Poutres en Ciment Armé.) A valuable article by M. Louis Stellet, upon the methods of proportioning constructive details of combined iron and concrete, including the researches of Hennebique, Cottancin, and others. 6000 w. La Revue Technique—Dec. 17, 1897. No. 17312 D.

Earthwork.

A Contribution to the Computation of Earthwork. (Ein Beitrag zur Erdmassenberechnung.) Giving a simplified approximate method especially adapted for cutting and filling, based upon the summation of a series of rectangular sections. 1200 w. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1897. No. 17360 D.

Roads.

First Report of Committee on Roads. A list of specimens of stone pavements imported and exhibited at the Pittsburg Exposition, with discussion of these and other systems. Ill. 6500 w. Pro Engs' Soc of W Penna—Sept., 1897. No. 17441 F.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Commerce.

The Trend of American Commerce. Cyrus C. Adams. Reviews the influences that are stimulating American commerce, and shows that energetic movements are being made to embrace opportunities for trade. 3300 w. Chau—Dec., 1897. No. 16993 C.

British India.

The Foreign Trade of British India. Account taken from the report of J. E. O'Connor, Director-General of Statistics to the Government of India. 900 w. Bd of Trd Jour—Nov., 1897. No. 16903 A.

China.

American Trade in China. J. T. M. Re-

ports an interview with T. R. Jernigan, ex-consul general of the United States to Shanghai, discussing the railway contract situation and the field for American supplies. Also editorial. 2500 w. Ry Age—Dec. 3, 1897. No. 17042.

The Opening Up of Southwestern China. Report of the opening of the territory of the West River to foreign trade. 3200 w. Bd of Trd Jour—Nov., 1897. No. 16902 A.

Competition.

Future Supremacy in the Iron Markets of the World. J. Stephen Jeans. Compares the relative advantages of various countries in point of crude materials, and shows the strength of England's position in this respect. 4500 w. Engineering Magazine—Jan., 1898. No. 17394 B.

Russian Competition with Indian Trade. An explanation of the conditions and the class of goods most affected, with suggestions of steps necessary to maintain British trade. 1300 w. Bd of Trd Jour—Dec., 1897. No. 17465 A.

Currency Plan.

The Secretary of the Treasury's Currency Plan. Statement of the recommendations of Mr. Lyman J. Gage, Secretary of the United States Treasury. 1700 w. Eng & Min Jour—Dec. 11, 1897. No. 17103.

Discriminating Duties.

Discriminating Duties in the United States. Letter from the Attorney-General to the Secretary of the Treasury of the United States. 3500 w. Bd of Trd Jour—Dec., 1897. No. 17-467 A.

English Colonies.

The Colonies: Their Arts, Manufactures and Commerce. Owen Tudor Burne. Gives general facts and figures relating to the condition of the colonies, and shows that their commerce holds a good position in the world. 6500 w. Jour Soc of Arts—Nov. 19, 1897. No. 16905 A.

Foreign Markets.

Another Lesson from Germany. Editorial on the account given by British Consul Powell to Lord Salisbury, of the Association for the promotion of foreign commercial relations with Stettin, showing its aims and objects. 1200 w. Engng—Dec. 17, 1897. No. 17418 A.

How to Win the Foreign Market. Henry C. Carpenter. A letter to the Department of State giving a few hints to American manufacturers who want business and are willing to work for it. 1600 w. Cons Repts (U. S. A.)—Dec., 1897. No. 17204 D.

German Association for the Promotion of Foreign Trade. An account of means taken to extend and improve the trade of Stettin. Consular report giving information to the Foreign Office of British Empire. 1700 w. Bd of Trd Jour—Dec., 1897. No. 17464 A.

Our Foreign Trade Methods at Fault. An explanation of the conditions to be met with and the methods now in use for extending American trade; also suggestions of necessary steps to be taken if much business is secured. 3800 w. Cons Repts (U. S. A.)—Dec., 1897. No. 17205 D.

Japan.

Trade Organization in Japan. An account of customs in trade, showing that guilds are common and trade associations numerous. 1400 w. Dom Engng—Dec., 1897. No. 17270 C.

Tariff.

Import Duties on Spirits and Wine in British Colonies and Possessions. Table showing the rates levied on spirits and wine imported into India, Ceylon, Canada, the Australasian Colonies, Natal, and the Cape of Good Hope. 2000 w. Bd of Trd Jour—Dec., 1897. No. 17466 A.

Influence of the Dingley Tariff on German Industries. Salient points of a memorandum drawn up by the Commercial Attaché of H. M. Embassy in Berlin, which gives a précis of a series of articles by experts on the subject in question. 3000 w. Bd of Trd Jour—Nov., 1897. No. 16901 A.

New Tariff of Cuba. A translation of the customs tariff for the island of Cuba, promulgated by the Spanish Government and printed in the *Gaceta de Habana* of September 9, 1897. 18000 w. Cons Repts (U. S. A.)—Dec., 1897. No. 17206 D.

Tariff Changes and Customs Regulations. Belgium, Netherlands, Germany, Italy, Switzerland, United States, Ecuador, Peru, Chile, Canada and Natal. 3300 w. Bd of Trd Jour—Nov., 1897. No. 16904 A.

Tariff Changes and Customs Regulations. Russia, Germany, France, Portugal, Spain, United States, Venezuela, Cape Colony, Victoria. 3500 w. Bd of Trd Jour—Dec., 1897. No. 17468 A.

CURRENCY AND FINANCE.

American Currency.

American Banking and Currency Schemes. W. R. Lawson. Considers the various phases of the subject, and the schemes advanced. 7000 w. Bankers' Mag, Lond—Dec., 1897. No. 17138 D.

Gold Sources.

The World's Quest for Gold. G. J. S. Historical review of the gold supplies, with comparison of the production of the past and present. 1600 w. Bankers' Mag, Lond—Dec., 1897. No. 17139 D.

Monetary Commission.

Monetary Commission Questions. A series of questions, formulated by the Monetary Commission appointed by the Indianapolis convention to investigate the banking and currency question and report a bill on the subject, with brief answers. 3000 w. Gunton's Mag—Dec., 1897. No. 17071 C.

The Monetary Commission. Portraits and sketches of the men who are at work on a plan of currency reform. 4000 w. Bankers' Mag, N. Y.—Dec., 1897. No. 17140 D.

GOVERNMENTAL CONTROL.

Interstate Commerce.

Annual Report of the Interstate Commerce Commission. Gives the principal part of the

abstract prepared by the Secretary of the Commission. Deals with rates, powers of the commission, long and short haul, pooling, etc. 3500 w. R R Gaz—Dec. 24, 1897. No. 17414.

"The Long and Short Haul Clause Invalidated." A Criticism. Milton H. Smith. A letter called forth by an editorial on the Alabama Midland decision. 3500 w. Ry & Engng Rev —Dec. 4, 1897. No. 17043.

Railway Legislation.

Prospects for Railway Legislation at Washington. Editorial discussion of bills likely to be brought before Congress, relating to pooling, ticket scalping, freight equipment, etc. 2500 w. R R Gaz—Dec. 16, 1897. No. 17178

LABOR.

Cheap Production.

Automatic Machinery the Secret of Cheap Production. Hiram S. Maxim. Compares the cost of hand work with that of automatic machinery, especially in the cases of gun and bicycle making, and claims the automatic machines benefit labor as well as effect cheap production. 4500 w. Engineering Magazine—Jan., 1898. No. 17395 B.

Engineering Strike.

The Approaching Conference. Editorial comment on the present condition of affairs and the influence on the engineering interests of England. 4000 w. Engng—Nov. 19, 1897. No. 16908 A.

The Engineers' Conference. Report of the points of dispute, giving the respective positions taken by the employers' federation and by the workmen's representatives. 1800 w. Prac Eng —Dec. 10, 1897. No. 17216 A.

Labor Costs.

Comparative Labor Costs. Discussion of this subject with criticisms of the position taken by Mr. Jeans in articles published in the *Engineering Magazine*. 3300 w. Gunton's Mag—Dec., 1897. No. 17072 C.

Labor Demands.

Collective Bargaining. An editorial explanation of the term, and of what trade unionism demands. 2500 w. Engng—Dec. 17, 1897. No. 17419 A.

Mexico.

The Condition of the Laboring Classes in Mexico. Theodore C. Knauff. Excerpts from a lecture delivered at Association Hall, Philadelphia. Interesting account of this country and the conditions affecting the laboring classes. 4200 w. Sci Am Sup—Dec. 18, 1897. No. 17166.

Unions.

Fifty Years of Unionism; A Retrospect. Editorial review of the trade dispute in 1852. Comparison is made, step by step, with the present dispute, showing that they were on similar and parallel lines and that history may repeat itself. 3300 w. Engng—Dec. 10, 1897. No. 17228 A.

United States Mines.

Labor Conditions at the Anthracite Mines of the United States. A review of the history of these mines since 1820, giving information of the workers, wages, accidents, conditions of life, &c. 3500 w. Col Guard—Dec. 10, 1897. No. 17235 A.

Wages.

Fair Wages. Editorial discussion of the report, just issued, by the Select Committee appointed to consider the working of the Fair Wages Resolution, passed by the House of Commons in England. 2500 w Engng—Nov. 26, 1897. No. 17009 A.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Copper Assay.

See Mining and Metallurgy. Copper.

Electric Welding.

The Voltex Process of Electric Welding. Illustrated description of a new process, also applicable to brazing, soldering, or lead burning, recently brought out by G. W. de Tunzelmann. 700 w. Ir & Coal Trds Rev—Nov. 26, 1897. No. 16995 A.

Electrolysis.

The Electrolytic Separation of Cadmium and Zinc, &c. (Die Elektrolytische Trennung von Cadmium und Zink, etc.) With details of methods for separating cadmium and zinc; zinc and cobalt; and antimony and tin. 4500 w. Zeitschr f Elektrochemie—Nov. 20, 1897. No. 17384 B.

The Decomposition of Salt. (Zur Kochsalzzerlegung.) An investigation of the difference between the theoretical and observed voltage, for the decomposition of chloride of sodium. 1000 w. Zeitschr f Elektrochemie—Nov. 20, 1897. No. 17385 B.

Electrolytic Copper.

The Progress of Electrolytic Copper. A general description of the operations necessary for its production, reviewing the history of the subject and the unparalleled growth of this industry. 3500 w. Ind & Ir—Nov. 19, 1897. No. 16914 A.

Electro-Zincing.

Electro-Zincing. Sherard Cowper-Coles. Abstract of a paper read before the Liverpool Engineering Society. Points out the importance of galvanizing and gives an idea of the process of electro-zincing, with a description of the plant employed. Ill. 3500 w. Elec Eng, Lond—Nov. 26, 1897. No. 16997 A.

Iodoform.

The Electrical Production of Iodoform (Ueber die Herstellung von Jodoform auf Elektrolytischem Wege.) Foerster & Meves. Discussing

the details of the method producing iodoform by electrolyzing an alcoholic solution of iodide of potassium through which carbonic acid gas is passed. 3000 w. Zeitschr f Elektrochemie—Dec. 5, 1897. No. 17386 B.

LIGHTING.

Arc Lamps.

Enclosed Arc Lamps. Discussion of paper by W. H. Freedman, H. S. Burroughs, and J. Rapaport, on "Efficiency and Life of Carbons in Enclosed Arc Lamps." 4400 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17080 D.

Tests of an Alternating Current Enclosed Arc Lamp. Illustrated description of some experiments conducted by M. H. Baker, showing how a small variation of voltage causes a large variation of light, and stating the requirements of good service. 1100 w. Elec Wld—Dec. 11, 1897. No. 17045

Astoria Hotel.

See Electrical Engineering, Power.

Brussels.

Brussels Electric Lighting Stations. Ernest Kilburn Scott. Describes what is considered to be a model electric light installation. 2400 w. Ind & Ir—Nov. 26, 1897. No. 17026 A.

Distribution.

The Distribution of Electrical Energy in Paris. A summary of report recently presented by M. Charles Bos, municipal councillor, giving much information of electric lighting in France, with comparison with other countries. 2400 w. Elec Rev, Lond—Dec. 17, 1897. No. 17428 A.

Gas Power-Plant.

See Mechanical Engineering, Motors.

Governing.

See Mechanical Engineering, Engines.

Incandescent Lamps.

Life and Candle-Power of Incandescent Lamps. From a recent publication issued by the General Electric Co., showing the folly of using lamps after their candle power has diminished. 3700 w. Elec Wld—Dec. 25, 1897. No. 17252.

The Importance of Quality in Incandescent Lamps. Francis W. Wilcox. Quality of far more importance than first cost. Defines a standard of valuation based on the maintenance of candle power during a given period. 2000 w. Elec Wld—Dec. 11, 1897. No 17047.

Isolated Plants.

Small Lighting Plants. Frederick C. Reeve. Discusses whether lighting companies can materially lower the present rates; whether small plants are practical; and under what conditions they can be made a financial success. 1100 w. Elec Wld—Dec. 4, 1897. No. 16976.

Lighthouses.

See Civil Engineering, Harbors.

Municipal Lighting.

See Municipal Engineering, Miscellany.

Photometry.

Photometric Measurements of Arc Lamps using Alternating Current. (Photometrische Messungen an Wechselstrombogenlampen.) Dr. Wedding. Giving photometric curves from a large number of observations, together with tables showing the relations between current strength and illuminating power. 5000 w. Elektrotechnische Zeitschr—Nov. 25, 1897. No. 17382 B.

Storage Batteries.

One of the Useful Applications of the Storage Battery. William Baxter, Jr. Shows its value as an adjunct to electric-lighting stations. 1300 w. Sci Am—Dec. 18, 1897. No. 17163.

Theatres.

Electricity in the Theatre. George Heli Guy. Reviews the many ways in which electricity is utilized in stage craft. 3500 w. Chau—Dec., 1897. No. 16994 C.

Underground Circuits.

Underground Circuits for Arc Lighting. S. H. Sharpsteen. Notes from the experience of the writer. 2400 w. Elec Eng, N. Y.—Dec. 2, 1897. No. 16943.

Washington, D. C.

The New Plant of the United States Electric Lighting Company at Washington, D. C. George H. Draper. Description of a modern station and its equipment. 3000 w. Elec Rev, N. Y. —Dec. 22, 1897. No. 17244.

POWER.

Astoria Hotel, New York.

The Electric Plant of the Astoria Hotel. Illustrated detailed description of this interesting isolated plant, which probably carries the greatest load of any isolated plant in existence. The lamps number over 25000, besides 21 electric elevators, and an amount of auxiliary electrically driven apparatus. 3800 w. Elec Wld—Dec. 25, 1897. No. 17250.

Bradford, Eng.

Bradford Corporation Electricity Supply. Robert Porter. Read before the Manchester District Institution of Gas Engineers. Descriptive of the Bradford electricity works. Followed by discussion. 3800 w. Jour of Gas Lgt—Nov. 30, 1897. No. 17058 A.

Central Stations.

The Tendency of Central Station Development. Part first discusses the distribution systems, and the changes of the last few years. 2000 w. Elec Wld—Dec. 4, 1897. Serial. 1st part. No. 16977.

Electrical Equipment.

The Electrical Equipment of the American Lithographic Company Building, New York City. Illustrated detailed description of a well-designed plant. 4500 w. Elec Eng, N. Y.—Dec. 30, 1897. No. 17461.

Dynamos.

Alternating-Current Dynamo Tests. Horace Field Parshall. From the *Proceedings of the Institution of Civil Engineers*, England. Investigations made to determine efficiency at different loads, to obtain quantitative results,

and to establish an economical, accurate and comprehensive method of testing. 4000 w. Elec Eng, Lond—Dec. 17, 1897. No. 17432 A.

Compound Dynamos and Their Action. James T. Jennings. Information regarding the action of compound-wound generators working in multiple. 1800 w. Am Elect'n—Dec., 1897. No. 16988.

Electric Hauling.

An Electrically-Driven Hauling Plant. From a communication by N. Phillippi, to the *Berg- und Hüttenmännische Zeitung*. Illustrated detailed description of the plant at the Kaiserin Auguste pit of the Gottessegen Colliery. Ill. 2800 w. Col Guard—Nov. 19, 1897. No. 16922 A.

Electric Launch.

See Marine Engineering.

Fire Risk.

The Fire Risk of Electrical Power Installations. A. Lester Taylor. Read before the Manchester (Eng.) Insurance Institute. Notes the rapid extension in the use of electric power, with consideration of the additional fire risk, reviewing the experience, and the precautions necessary. 5800 w. Elec Rev, Lond—Dec 17, 1897. No. 17430 A.

Flushing, N. Y.

The Flushing, L. I., Electric Light and Power Station. Illustrated detailed description of a small plant, the characteristic of the service being an extremely low load factor. 2300 w. Elec Eng, N. Y.—Dec. 2, 1897. No. 16942.

Gas Power Plant.

See Mechanical Engineering. Motors.

Generators.

Regulation of Field Current in a Three-Phase Generator Working Singly with a Widely Varying Motor Load, also Three-Phase Motors in Practice. Arthur H. Gibson. Suggests a device for overcoming the difficulty. 700 w. Elec Rev, Lond—Dec. 3, 1897. No. 17122 A.

Setting Up Large Generators. George T. Hanchett. Points on the setting of a dynamo of the direct-connected multipolar type. Attention is called to faults of these machines. Ill. 2500 w. Elec Wld—Dec. 4, 1897. No. 16975.

Hoisting Machinery.

Electric Lifts and Cranes. H. W. Ravenshaw. Read before the Institution of Civil Engineers, England. The object is to direct attention to electrical and mechanical problems which present themselves in the application of electric motors to lifts and cranes, and to describe methods by which they have been solved in particular cases. Ill. 1800 w. Elect'n—Nov. 19, 1897. Serial. 1st part. No. 16925 A.

Hydraulic Power Plant.

Water Power and Electric Plant at the Adda Rapids, Near Paderno, Italy. Illustrated detailed description. 2200 w. Elec Eng, N. Y.—Dec. 9, 1897. No. 17067.

Hydraulics.

See Mechanical Engineering, Power and Transmission.

Induction.

Steinmetz on Induction Motors. Discussion of paper read by Charles P. Steinmetz, at Eliot, Me. 3000 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17073 D.

Induction Motors.

A Simple Method of Starting Alternating Single Phase Induction Motors. Riccardo Arno. A paper read before the Associazione Elettro-technia Italiana. 1700 w. Elec Rev, Lond—Nov. 26, 1897. No. 17016 A.

Power House.

See Street and Electric Tramways.

Regulator.

Water-Wheel Regulation. Samuel N. Knight. Refers to methods in use, stating why they are objectionable and describes apparatus adopted by the writer. 1700 w. Jour of Elec—Nov., 1897. No. 17050.

Rheostats.

Practical Use of Water Rheostats. Edward J. Willis. Also, A Note on Water Rheostats. E. A. Merrill. A few points and suggestions to those who have charge of such work. 2800 w. Am Elect'n—Dec., 1897. No. 16987.

Shop Driving.

Electric Power Work in Ironworks, Shipyards and Engineering Establishments. Abstracts of papers read at meeting of the Cleveland Inst. of Engineers, held at Middlesborough. 3000 w. Col Guard—Nov. 19, 1897. No. 16919 A.

Starting.

Concerning Starting Resistance for Motors. (Ueber Anlasswiderstande für Nebenschlussmotoren.) A paper by Herr Menges describing a method of introducing a starting resistance which is afterwards short circuited. 1500 w. Electrotech Zeitschr—Dec. 2,1897. No.17383. B.

Stations.

The Lighting and Power Stations of the Richmond Railway and Electric Company. Illustrated detailed description of a plant of interest as an example of the evolution of practice during the last fifteen years. 1600 w. Elec Wld—Dec. 4, 1897. No. 16974.

Steam Engines.

See Mechanical Engineering. Engines.

Subdivision.

The Subdivision of Alternating Currents by Means of Transformers. (Verteilung von Wechselstrom mittels Transformatoren.) Showing the relative efficiency of transformers, and describing the Schlatter transformer system. 2500 w. Elektrotechnische Rundschau—Dec. 1, 1897. No. 17389 B.

Towing.

Trolley Connection and Locomotive for Towing Canal Boats. Describes the invention of Frederick J. Shewring; also the device invented by Edwin A. Leland. Ill. 700 w. Elec Eng, N. Y.—Dec. 23, 1897. No. 17264.

Transformers.

Alternate Current Transformer Design. The

article is a conclusion to a series of articles recently published in this paper, and gives a worked example of a simple design. Ill. 800 w. Elec, Lond—Dec. 10, 1897. Serial. 1st part. No. 17192 A.

Transmission.

The Newcastle-Sacramento Transmission Plant. Illustrated detailed description. 2300 w. Elec Wld—Dec. 18, 1897. No. 17143.

The Transmission of Energy to a Distance. (Sur la Transmission d'Energie à Distance.) A mathematical discussion of the application of rotary polarisation, by M. André Broca; presented to the French Academy by M. Cornu. 1000 w. Comptes Rendus—Nov. 15, 1897. No. 17317 D.

TELEGRAPHY AND TELEPHONY.

Fire Alarm.

The Montauk Multiphase Fire Cable. Illustrates and describes an ingenious system of fire alarm. 800 w. Sci Am—Jan. 1, 1897. No. 17462.

Galvanoscope.

Use of the Telephone as a Galvanoscope. George I. Hanchett. Shows modifications in the use of this instrument in testing, and indicates where it can be used to greater advantage than a galvanometer. Ill. 2000 w. Elec Eng, N. Y.—Dec. 23, 1897. No. 17263.

Glasgow.

The Glasgow Telephone Inquiry. An account of the recent inquiry into the causes of dissatisfaction with the service. 3800 w. Elec Eng, N. Y.—Dec. 16, 1897. No. 17147.

Police Service.

An Important System of Police Telephone Service for New York City. The McCullagh Plan. Brief detail of plan suggested by Chief John McCullagh for establishing permanent ports and police intercommunication, to increase the efficiency of the police force. 2000 w. Elec Eng, N. Y.—Dec. 16, 1897. No. 17148.

Statistics.

Telegraphic Statistics. A translation from the *Journal Télégraphique* relative to the progress of the various countries in telegraphic developments. 3000 w. Elec Eng, Lond—Dec. 3, 1897. No. 17159 A.

Telephone System.

Switch System for Telephone Exchange. (Schaltung für Gemeinschaftliche Fernsprechleitung.) A method of using a number of telephones upon a single wire; all but the one in use being automatically disconnected. Suitable for small systems. 1500 w. Elektrotechnische Zeitschr—Nov. 18, 1897. No. 17381 B.

Wireless Telegraphy.

Marconi Telegraphy. Description of the experiments made in Berlin and Vienna. Ill. 1400 w. Elec Rev, Lond—Dec. 3, 1897. No. 17121 A.

Signalling Through Space Without Wires. W. H. Preece. An address given before the Royal Institution. An interesting lecture giving a description of the method applied by the author, and also the method of Hertz used by Mr. Marconi. The first method utilizes electromagnetic waves of very low frequency; the second utilizes waves of very high frequency. Ill. 3500 w. Science—Dec. 17, 1897. No. 17180.

The Electrical Conductivity of Interrupted Conductors. (Sur la Conductibilité Electrique des Substances Conductrices Discontinus.) M. E. Branly. An account of experiments made in 1891-92 with coherers similar to those used by Marconi in wireless telegraphy. 1000 w. Comptes Rendus—Dec. 6, 1897. No. 17325 D.

Zerograph.

The Zerograph. Illustrated detailed description of a new instrument for doing the work of a type-printing telegraph. 1100 w. Elect'n—Nov. 19, 1897. No. 16924 A.

MISCELLANY.

Alternators.

Determination of the Virtual Electromotive Force of Alternators. Karsten Knudsen. A consideration of the practical applications of the magnetic field, and the electromotive forces set up in conductors when moving in a field of definite strength. 1200 w. W Elect'n—Dec. 11, 1897. Serial. 1st part. No. 17146.

Armatures.

Goldsborough on Armature Inductance. Discussion of paper by W. E. Goldsborough on "The Effect of Armature Induction upon the Electromotive Force Curves of an Alternator." 1700 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17076 D.

Condensers.

Macfarlane on Discharge of Condenser. Discussion of paper read May 18, 1897. 3800 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17074 D.

Converter.

Armature Reaction in a Rotary Converter. Discussion of paper by Robert B. Owens. 4400 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17081 D.

Currents.

The Alternating Current. Lawford H. Fry. An attempt to make clear the occurrences in a circuit carrying an alternating current of electricity, without using complicated mathematical formulæ. 2500 w. Am Mach—Dec. 23, 1897. No. 17275.

Three-Phase Current Measurement. Lawford H. Fry. Describes the method in use in the electrical laboratory of the Hanover Polytechnikum. It is simple and very economical in the number of instruments required, and in the time needed for a measurement. Ill. 800 w. Elec Rev, Lond—Dec. 10, 1897. No. 17213 A.

Electrical Discharges.

Electrical Discharges in Vacuo. J. Warren. Part first gives explanation of phenomena appearing in the discharges in vacuum tubes. 1700 w. Elec, Lond—Dec. 17, 1897. Serial. 1st part. No. 17427 A.

Electric Heating.

A Practical Application of Electric Heating.

Illustrated description with general particulars relating to the plant in the straw-hat factories of Wm. Carroll & Co., located at Matteawan, N. Y. 1400 w. Am Elect'n—Dec., 1897. No. 16985.

Electrical Measurements.

Electrical Measurement by Alternating Currents. Henry A. Rowland. Treats mainly of inductances, self and mutual, and of capacities together with their ratios and values in absolute measure as obtained by alternating currents. 5500 w. Am Jour of Sci—Dec., 1897. No. 16963 D.

Electric Welding.

The History of Electric Welding. A. J. Moxham. An account of the process and its progress, the laws governing the work and their adaptation to commercial practice. 3000 w. Ir Age—Dec. 30, 1897. No. 17472.

Induction.

Some Experiments on Induction with Currents of High Frequency at Long Distance. Edwin F. Northrup, George W. Pierce and Fritz Reichmann. An account of some experiments showing the subtle action of the ether and the power of resonance in electrical circuits. Ill. 1800 w. Elec. Wld. Dec. 18, 1897. Serial. 1st part. No. 17145.

The Action of Induction Apparatus. (Ueber die Vorgänge in Induktionsapparat.) An account of the investigations of Herr Walter, at Hamburg, into the relation between the condenser capacity and length of spark in induction coils. 1800 w. Elektrotechnische Rundschau —Nov. 15, 1897. No. 17388 B.

Insulation.

Bates and Barnes on Insulating Materials. Discussion of paper on "The Effect of Heat Upon Insulating Materials," by Putnam A. Bates and Walter C. Barnes. 4800 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17075 D.

High Potential Insulators. Frederic A. C. Perrine. A careful examination of the necessary details in the manufacture of porcelain for insulators and the need of careful study of material and form. 4200 w. Elec Engng—Dec. 15, 1897. No. 17249.

Isolated Plants.

Does It Pay to Generate Electricity or Buy It? An examination of this subject for the purpose of laying down some general rules under which separate plant would be justified. 1300 w. Mach, Lond—Dec. 15, 1897. No. 17426 A.

Lightning Protection.

I. Lightning on Transmission Lines. Theo. E. Theberath. II. Lightning at Sacramento. C. W. Hutton. III. Lightning in Nevada County. E. J. De Sabla, Jr. IV. Lightning and Long Transmission. E. W. Sutcliffe. V. Insulators for Transmission Lines. John Martin. Papers read before the Sacramento convention of the Pacific Coast Electric Transmission Assn. 10000 w. Jour of Elec—Nov., 1897. No. 17051.

Magnetism.

Recent Researches in Terrestrial Magnetism. A. W. Rücker. The "Rede Lecture" delivered in the Senate House, Cambridge, Eng. Presents some of the theories and speculations which are now attracting the attention of those interested in this science. 4400 w. Nature—Dec. 16, 1897. Serial. 1st part. No. 17433 A.

Metering.

Haskins on Electric Metering. Discussion of paper by Caryl D. Haskins on "Electric Metering from the Station Standpoint." 3700 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17077 D.

Ohm.

On a Determination of the Ohm made in Testing the Lorenz Apparatus of the McGill University, Montreal. W. E. Ayrton and J. V. Jones. A mean of 9 measurements, when carefully corrected, shows that 1 Board of Trade Ohm equals 1.00026 true ohms. The details of the tests are given. 2500 w. Ind & Ir—Nov. 19, 1897. No. 16912 A.

Resistance.

Our Knowledge of the Value of a Resistance. W. E. Ayrton. Considers the degree of accuracy with which the resistance of any particular conductor may be stated in absolute measure, at the present time. 2000 w. Elect'n, Lond—Nov. 26, 1897. No. 17029 A.

Roentgen Rays.

Experiments with Cathode and Röntgen Rays. J. Precht. Abstracted from *Wiedmann's Annalen*. Considers the deviation of cathode rays by a magnet and the properties of rays emerging from discharge tubes, giving experiments. Ill. 1600 w. Elec Wld—Dec. 18, 1897. No. 17144.

Shielding.

On Magnetic Shielding. H. Du Bois. Part first is somewhat introductory, explaining what has been accomplished, and the need of a fuller treatment of the subject. Gives also the theory of spherical and cylindrical bi-lamellar sheaths. 1700 w. Elect'n, Lond—Dec. 10, 1897. Serial. 1st part. No. 17227 A.

The Magnetic Shielding of Conductors of Electricity. Ernest Wilson. Describes experiments made by the author, with the object of getting a practical demonstration of the disturbances to be dealt with under different conditions. 1600 w. Elect'n, Lond—Dec. 17, 1897. No. 17424 A.

Sparking.

Sparking, Its Cause and Effects. Thorburn Reid. Read before the Am. Inst. of Elec. Engs. Considers the real injury is done before the segment leaves the brush. A study of commutation. 2500 w. Elec Rev, N. Y.—Dec. 22, 1897. Serial. 1st part. No. 17245.

Stress.

See Mining and Metallurgy, Iron and Steel.

Testing.

A New Magnetic Testing Apparatus. Robert B. Treat and J. Walter Esterline. Illustrated description of apparatus designed and constructed by the authors, at the laboratories of Purdue University, Lafayette, Ind. 1300 w. Elec Wld—Dec. 11, 1897. No. 17046.

Training.

How to Become an Electrical Engineer. George B. Lauder. First prize letter in the competition inaugurated by this paper. 1700 w. Elec Rev, N. Y.—Dec. 8, 1897. No. 17048.

Transformer.

The Ferraris-Arno Phase Transformer. (Phasen-transformator nach Ferraris-Arno.) Dr. Lombardi. A special form of motor transformer composed of a single phase alternating motor with auxiliary winding system, by means of which the amount and phase of the induced current is determined. Two articles. 6000 w. Elektrotechnische Zeitschr—Nov. 18, Dec. 2, 1897. No. 17380 E.

X Rays.

Apparatus for Determining the Position of Projectiles in the Skull. (Appareil Destiné à Determiner la Position des Projectiles dans le Crâne.) The method of MM. Remy and Contremoulins, presented to the French Academy by M. Marey consists in the use of two Crookes tubes, to make radiographs from known positions. 1500 w. Comptes Rendus—Nov. 22, 1897. No. 17319 D.

Gold-Foil Screens for X-Ray Practice. J. Elliott Woods. Further experiments with defence of previous arguments. 2000 w. Elec Rev, N. Y.—Dec. 1, 1897. No. 16941.

New System for Locating Bullets. Illustrates and describes a method, aided by radiographic proofs, which has proved most successful. 2400 w. Sci Am Sup—Dec. 25, 1897. No. 17265.

The Discharge of Electrified Bodies by the X Rays. Clement D. Child. Reviews briefly articles already published on this subject, and gives experimental work. 5500 w. Phys Rev—Oct., 1897. Serial. 1st part. No. 16300 D.

MARINE ENGINEERING.

Balancing.

The Yarrow-Schlick-Tweedy System of Balancing Engines. Several illustrations showing the results attained in the twin-screw steamship Avon, and in others, by the adoption of this system, with explanations. 1300 w. Engng—Dec. 17, 1897. No. 17417 A.

Battleships.

The Engineer and His War-Engine. R. H. Thurston. Traces the work of development in the modern war-vessel and discusses the relation of the personnel, the need of increasing the number of engineer officers, &c. 4200 w. N Am Rev—Dec., 1897. No. 16950 D.

Cellulose.

A New Form of Cellulose. E. L. Freeland. On the process, invented by Mark W. Marsden, utilizing the pith of cornstalks as an absorbent for water entering through shot-holes. The advantages are presented. 1200 w. Yale Sci M—Nov., 1897. No. 16932 C.

Electric Launch.

Electric Launch for the Czar of Russia. Gives dimensions and construction, fittings and furnishings and electrical equipment of this boat being built by the Electric Launch Co., of New York. Ill. 1300 w. Elec Eng, N. Y.—Dec. 16, 1897. No. 17149.

Fans.

Centrifugal Fans as Applied to Marine Uses. G. M. Capell. Read before the Institute of Marine Engineers, at Stratford. Reviews the improvements in the last fifteen years in the construction of fans and their use in mines as well as marine uses. 2200 w. Engs' Gaz—Dec., 1897. No. 17053 A.

Fishing Vessels.

The Ocean Fisheries and the Professional Instruction of Mariners. (Les Pèches Maritimes et l'Enseignement Professionnel des Marins.) M. Perard. A discussion of the commercial value of the North Sea fisheries and an account of the construction of the fishing vessels, and the schools for instruction of fishers in France. 10000 w. Bulletin de la Société d'Encour—Nov., 1897. No. 17349 F + G.

Gunboats.

Light-Draught Gunboats for the United States Navy. Description of the Nashville, Wilmington and Helena as representing a class intended for special duty in shallow bays and rivers. Ill. 2500 w. Engr, Lond—Dec. 3, 1897. No. 17124 A.

Loading.

Loading of Vessels Engaged in "Klondike" Trade on the Pacific Coast. James S. Tyler. An account of the arrangements made to meet the sudden increase in passenger and freight traffic. 2000 w. Marine Engng—Dec., 1897. No. 17142 C.

Marine Machinery.

Estimated Weights of Marine Machinery. George R. McDermott. Abstract of paper read at meeting of the Society of Naval Architects and Marine Engineers. Gives the result of investigations made regarding methods for determining the weights of machinery of steamships. 2300 w. Sib Jour of Engng—Dec., 1897. No. 17247 C.

Propellers.

On the Influence of Surface on the Performance of Screw Propellers. W. F. Durand. Read before the Society of Naval Architects and Marine Engineers, New York. Illustrated description of investigations, the essential feature being the relation of the amount of area of the blade to the performance as a whole. 6000 w. Marine Engng—Dec., 1897. No. 17141 C.

Something About Screw Propellers. John H. Meyer. A study of the action and the effect is given in part first. Ill. 1400 w. Engr, N. Y. —Dec. 1, 1897. Serial. 1st part. No. 17031.

Roller Boat.

The Theories Upon which the Knapp Roller Boat was Built. Robert W. Rayson. The idea was to obtain the greatest contact with the water

and therefore the greatest resistance, because this tends to lift the boat out of her displacement and decrease the power necessary to acquire speed. 1500 w. Sci Am—Dec. 18, 1897. No. 17164.

Salvage.

The Raising of the Four Master "Europe." (Remise à Flot du Navire Quatre-Mats "Europe.") Describing the righting of a steel vessel of 3500 tons displacement which had been grounded and capsized by an unexpected tidal change. An important and valuable paper. 3500 w. La Revue Technique—Dec. 10, 1897. No. 17311 D.

Shipbuilding.

Shipbuilding as a Productive Industry in Great Britain. James McKechnie. Showing the reciprocal influence of private enterprise and naval dominion with especial reference to the growth of ship-building on the Clyde and at Barrow subsequent to the Naval Defense Act. 4000 w. Engineering Magazine—Jan., 1898. No. 17393 B.

Comparison and Construction of Ships' Lines. Archibald Hogg. Read before the Northeast Coast Inst. of Engineers and Shipbuilders, at Newcastle-on-Tyne. Illustrates a method of comparison and construction of the under-water part of a ship's hull. 2800 w. Ind & Ir—Nov. 19, 1897. No. 16913 A.

Torpedo Boats.

The Stranding of the "Thrasher." Interesting illustrations showing the damage sustained by this torpedo-boat destroyer, which ran ashore on the rocks of Dodman Point, with comments. 1800 w. Engng—Nov. 26, 1897. No. 17010 A.

Twin-Screw Steamer.

The Carron Company's T. S. S. "Avon.' Illustrated description. 1500 w. Engng—Nov. 19, 1897. No. 16910 A.

Unloading.

A Contractor's Movable Landing Stage. Describes an arrangement used by F. H. Hebblethwaite in unloading a quantity of material from vessels in Manaos, in the Rio Negro, Brazil. 1300 w. Eng Rec—Dec. 4, 1897. No. 17039.

Yachts.

Notes on the Yacht Defender and the Use of Aluminum in Marine Construction. Richmond Pearson Hobson. Extract from a paper contributed to the United States Naval Institute. Deals with corrosion, and the importance of aluminum in marine construction. 2000 w. Sci Am Sup—Dec. 18, 1897. No. 17165.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Management.

On the Management of Steam-Boilers. F. G. Ansell. Considers how to ensure full efficiency and avoid all possible risk of danger, discussing firing and feed-water. 3200 w. Elec Eng, Lond—Dec. 10, 1897. No. 17222 A.

The Management of Boilers and Steam Plant, Including Details of Steam Pipes and Fittings. A. B. Mountain. Read before the Northern Society of Electrical Engineers, at Manchester, Eng. The author's experience with various types of steam generators is given and consideration of details named. 5500 w. Ind & Ir—Dec. 17, 1897. No. 17455 A.

Circulation.

A Study of the Circulation of Water in Multitubular Boilers. (Etude de la Circulation de l'Eau dans les Chaudières Multitubulaires.) H. Brillié. A discussion of the circulation in water-tube boilers comparing the theories of English, American and French engineers, and a mathematical investigation based on experimental data. Serial. Part I. 4000 w. Le Génie Civil—Dec. 4, 1897. No. 17306 D.

Explosions.

Accidents Caused by the Rupture of Boiler Flues. (Accidents Causés par des Ruptures de Tubes à Fumeé.) M. C. Walckenaer. Report of the secretary of the central commission of steam machinery (France) with discussion of the failures of boiler flues from 1888 to 1896. 7500 w. 1 plate. Ann des Ponts et Chaussées—Part III. 1897. No. 17346 F + G.

A Terrible Boiler Explosion and Its Lesson. An account of the explosion which occurred Nov. 22, at the Graves Elevator Works, Rochester, N. Y. The cause is supposed to have been a crack hidden in the joints by the over-lap of the sheets. 1800 w. Am Mach—Dec. 16, 1897. No. 17160.

Explosion of a Marine Boiler. (Explosion eines Schiffskessels.) With very clear photographs showing the ruptured rear end of the cylinder. The metal was found to be crystallized. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 27, 1897. No. 17335 D.

Fireboxes.

Staying of Locomotive Fireboxes. A discussion of this subject, dealing with fireboxes made in accordance with English practice, with internal plates of copper and exterior shell plates of iron or steel, the material used for the stays being copper. 2300 w. Engng—Nov. 19, 1897. Serial. 1st part. No. 16909 A.

Forced Draught.

The Meldrum System of Forced Draught. Describes and illustrates this system, of ash pit steam jets and states the advantages that accrue from its adoption. 1500 w. Ry Wld—Dec., 1897. No. 17211 A.

Frost Damage.

Damage to Steam Boilers by Frost. Examples are given showing that even boilers built of heavy plate and tested at high pressure cannot be exposed to cold weather with impunity. Ill. 500 w. Power—Dec., 1897. No. 17201.

Injectors.

A Comparative Test of Steam Injectors. George Henry Trautmann. A thesis submitted for the degree of Bachelor of Science in Mechanical Engineering, University of Wisconsin. Comparative tests of a number of well-known makes. Ill. & tables. 2500 w. Bul of Univ of Wis—No. 12. No. 17082 C.

The Injector. M. W. Roe. Describes the mechanism and action of the injector, and reports a test. 1200 w. Sib Jour of Engng—Dec., 1897. No. 17248 C.

Lancashire Boiler.

Specifications for a Lancashire Boiler 30 ft. x 8 ft., for 200 lb. Working Pressure. Sam Boswell. Points out the main features and gives dimensions and details. 1300 w. Prac Eng—Dec. 17, 1897. No. 17453 A.

Smoke.

The Smoke Nuisance and its Regulation, with Especial Reference to the Condition Prevailing in Philadelphia—Improved Furnaces and Mechanical Stokers. Illustrated detailed description of the construction and operation of various stokers and furnaces. 8000 w. Jour Fr Inst—Dec., 1897. Serial. 1st part. No. 17094 D.

Stay Bolts.

Pneumatic Stay-Bolt Breaker, Atchison, Topeka and Santa Fé Railway. Illustrated description of the invention of John Player, by use of which the removal of the inner shell of the fire box from a locomotive boiler becomes a simple operation. 1200 w. Ry & Engng Rev—Dec. 18, 1897. No. 17239.

Strains.

The Strains on Cover-Plate Bolts. From the *Locomotive*. Extracts from an article studying the tension to which the bolt is subjected when under steam. 1000 w. Bos Jour of Com—Dec. 25, 1897. No. 17290.

Vacuum Pan.

Apparatus for Boiling Sirup. (Appareil pour Cuire les Sirops.) Illustrated description of the Ehrenstein evaporating pans and sugar filters. The evaporation is effected by high pressure steam coils in vacuum pans. 1000 w. 1 plate. Le Génie Civil—Nov. 13, 1897. No. 17301 D.

Water-tube Boiler.

Water-Tube Boilers, H. M. S. Salamander. Describes a new water-tube boiler made for this English torpedo-destroyer. 1300 w. Engr, Lond—Dec. 3, 1897 No. 17126 A.

COMPRESSED AIR.

Cold Storage.

Cold Storage and Cold Rooms from Compressed Air. G. D. Hiscox. An explanation of the conditions of air expansion applied to the practical effects of refrigeration, with diagram showing much that is interesting in regard to the general conditions. 1800 w. Compressed Air—Dec., 1897. No. 17277.

Cooling.

Regulating Temperature of Buildings by Compressed Air. Presents a plan showing in detail the system employed by the Davis & Roesch Co. of New York. Ill. 500 w. Compressed Air—Dec., 1897. No. 17279.

Explosions.

Explosions in Air-Compressors. From an article by F. Strnad in *Gluckauf*. A discussion of the causes and remedies of explosions, giving details of explosions in Europe. In cases cited an explosive mixture of air and oil vapor were ignited by the heat of compression. Gives precautionary measures. 2800 w. Col Guard—Dec. 10, 1897. No. 17231 A.

Foundry Plant.

A Model Compressed Air Foundry Plant. H. M. Perry. Illustrated description of a foundry crane in the works of John J. Radley & Co., New York. 600 w. Compressed Air—Dec., 1897. No. 17278.

Haulage.

Mechanical Haulage by Compressed Air. E. P. Lord. Abstract of a paper read at a meeting of the Anthracite Coal Operators' Assn., New York. Presents its advantages over other classes of haulage, and gives information relating to the installation and operation of the plant. 4500 w. Col Guard—Nov. 26, 1897. No. 17025 A.

Hydraulic Compressor.

Hydraulic Plant for Compressing Air. H. D. Pearsall. Read at meeting of Manchester (Eng.) Assn. of Engineers. The author confines his attention to those hydraulic air compressors which have attempted to apply the water directly. 3600 w. Col Guard—Dec. 3, 1897. No. 17155 A.

Pneumatic Transmission.

Pneumatic Mail-Tube System, New York City. Illustrated description of the installation, and the method of operation, with historical account of its use in other cities. 3400 w. Sci Am—Dec. 11, 1897. No. 17064.

ENGINES AND MOTORS.

Condensers.

Ejector Condensers v. Jet Condensers and Air Pumps. Illustrated description of the ejector condenser and a statement of its advantages. 900 w. Prac Engr—Nov. 26, 1897. No. 17028 A.

Expansion Engines.

Expansion Engines for Land Service. W. H. Hoffman. A lecture before the Massachusetts Assn. of Steam Engineers. Considers compound, triple and quadruple expansion engines, and gives suggestions helpful to those in charge. Ill. 1700 w. Elec Eng, N. Y.—Dec. 9, 1897. No. 17068.

Friction.

Note on the Variations of Frictional Resistance in Steam Engines. (Ein Beitrag zur Beurteilung der Zusätzlichen Reibung bei Dampfmaschinen.) A discussion of the conditions under which the friction increases and diminishes with the variations of the load upon the engine. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 20, 1897. No. 17331 D.

Gas Engines.

Gas and Gasolene Engines. E. W. Roberts. Their adaptability to mining work and their merits compared with other motors are discussed, with a description of the uses to which they may be applied and the conditions under which they insure efficiency, economy and convenience in mines. Ill. 4000 w. Mines & Min—Dec., 1897. No. 17170 C

Gas and Petroleum Engines at the Brussels Exhibition. Some interesting information with illustrated description of engines contributed by British makers. 1400 w. Engng—Nov. 19, 1897. Serial. 1st part. No. 16907 A.

The Application of Furnace Gases for Motive Power. (Die Verwendung der Hochofen Gichtgase zur Erzeugung Motorischer Kraft.) Showing that better economy is obtained by using furnace gases in gas engines than by burning them under steam boilers. A review of the experiments at Liège. Two articles. 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 30, Nov. 6, 1897. No. 17373 E.

The Economy and Efficiency of the Large Gas Engine. Dugald Clerk. A review of the latest practice by a pioneer in this field with many illustrations of large engines. The prediction is made that gas engines as powerful as any steam engines will be built. 4000 w. Engineering Magazine—Jan., 1898. No. 17397 B.

The Petroleum, Gas and Naphtha Motors at the Nijni-Novgorod Exposition, 1896. (Die Petroleum,—Gas,—und Napthamotoren der Ausstellung in Nischniji-Nowgorod, 1896.) A variety of explosion motors were shown, including several portable petroleum motors for agricultural use. 4000 w. Zeitschr d ver Deutscher Ing—Nov. 20, 1897. No. 17330 D.

Gas Power Plant.

Gas-Producing Plant and Gas-Engines for Electricity Works. Report by Prof. Henry Robinson on the Leyton Urban District Council's electricity station, giving information of interest to those who are concerned in deciding as to the relative merits of steam and gas plants. 2500 w. Elec Eng, Lond—Dec. 10, 1897. No. 17223 A.

The Leicester Gas-Power Electric-Lighting Station of the Midland Railway. Particulars as to the equipment and working of this station, which is one of the most successful in England. Ill. 1100 w. Elect'n, Lond—Dec. 17, 1897. No. 17425 A.

Governors.

Engine Governors. R. H. Smith. Part first explains the need of varying the design and operation of governors to suit the machine to which they are applied; also considers the whole operation of governing. 4500 w. Engr, Lond—Nov. 26, 1897. Serial. 1st part. No. 17017 A.

On Methods of Testing Engine Governing. F. W. Roller. Explanation of the methods of testing how well the governors of steam engines for electric work fulfil their purpose. Ill. 2400 w. Am Elect'n—Dec., 1897. No. 16986.

Heat Motor.

Diesel's Rational Heat Motor. From *Zeitschrift des Vereines Deutscher Ingenieure.* Translation of a lecture delivered by Rudolph Diesel, with illustrations and tables. Also editorial. 4000 w. Pro Age—Dec. 1, 1897. Serial. 1st part. No. 16945.

Indicator.

Little's Continuous Recording Indicator. Illustrated description of an instrument capable of integrating continuously the work done in the cylinder of an engine under all conditions of varying load, explaining the theory. 2700 w. Engng—Dec. 10, 1897. No. 17229 A.

Indicator Diagrams.

The Commercial Value of Indicator Diagrams. Sidney R. Lowcock. Read before the South Staffordshire Institute of Iron and Steel Works Managers. Showing that diagrams, when properly taken, furnish a complete record of what takes place in the engine cylinder, and enable one to decide what steps to take to improve the economy. 1300 w. Col Guard—Nov. 26, 1897. No. 17023 A.

Pumping Engine.

Triple Expansion Pumping Engine for the City of Mexico. Front and side elevation of the engine and pumps, with brief description and report of fine record made in the shipment from Lockport, N. Y. 700 w. Eng News—Dec. 2, 1897. No. 16990.

Regulator.

See Electrical Engineering, Power.

Steam Engines.

Steam Engine Construction and its Relation to Electrotechnics. (Der Dampfmaschinenbau und Seine Beziehungen zur Elektrotechnik.) A general discussion by Prof. Gutermuth of the modifications which have been wrought in engine construction by the demands for electrical service. 7000 w. Zeitschr d Ver Deutscher Ing—Dec. 11, 1897. No. 17337 D.

Valve Gear.

The Proell-Corliss Engine and the Proell Valve Diagram. Hermann Kuhne. Read before the Inst. of Engineers and Shipbuilders in Scotland, Oct. 26, 1897. Illustrated description of the Proell expansion apparatus, and the engine named. 1300 w. Prac Eng—Dec. 10, 1897. No. 17217 A.

POWER AND TRANSMISSION.

Friction Wheels.

Experiments with Friction Wheels. (Versuche mit Reibrädergetrieben.) Describing a number of tests made with metal disk friction wheels, with wheels of paper, wood and cast iron; and with the Sellers variable friction gear. An electric motor furnished the power, and the measurements were made with a Prony brake. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 27, 1897. No. 17336 D.

Grain Elevator.

Grain Elevator in Copenhagen. Translated from *Oesterreichische Monatsschrift für den Oeffentlichen Baudienst.* Illustrated description. 1000 w. Sci Am Sup—Dec. 4, 1897. No. 16973.

Hydraulics.

Hydraulic Problems. W. Stuart Smith. Read before the Sacramento convention of the Pacific Coast Electric Transmission Assn. The difficulties that arise in the development of a water power. 3800 w. Jour of Elec—Nov., 1897. No. 17049.

Motive Power.

Steam, Gas, and Electrical Energy as Applied to Chemical Works. F. H. Bowman. Read before the Manchester Section of the Society of Chemical Industry. Abstract of views on each power named is given. 1200 w. Gas Wld—Dec. 11, 1897. No. 17221 A.

Safety Coupling.

The Viviez Automatic Safety Coupling. (Selbstthätige Sicherheitskupplung von Viviez.) An automatic coupling for rolling-mill use, which will release the connection under excessive strains before breakage can occur. 600 w. Zeitschr d Ver Deutscher Ing—Nov. 13, 1897. No. 17329 D.

Steam Power.

Foster on Cost of Steam Power. Discussion of paper by H. A. Foster, read July 28, 1897. 3300 w. Trans Am Inst of Elec Engs—Oct., 1897. No. 17079 D.

See Mining and Metallurgy, Mining.

Water Motors.

Making Practical Water Motors. George D. Rice. Describes and illustrates three new forms of these machines. 800 w. Dom Engng—Dec., 1897. No. 17268 C.

Water Power.

The Motive Power of the Arc. (Les Forces Motrices de l'Arc.) Giving an illustrated description of the various power stations which utilize the force of this mountain torrent of upper Savoy between Modena and Saint-Michel. 3500 w. La Revue Technique—Nov. 25, 1897. No. 17308 D.

Windmills.

Power of a Twelve Foot "Power" Windmill. E. C. Murphy. Discusses the results of tests of this windmill, from a mathematical standpoint. 2500 w. Kansas Univ Quar—Oct., 1897. No. 17137 D.

SHOP AND FOUNDRY.

Bearings.

Babbiting and Fitting Bearings. All the babbitted surfaces met with in an ordinary engine are discussed and illustrated, with instructions. 2500 w. Power—Dec., 1897. No. 17202.

Belt Transmission.

The Transmission of Power by Belts and Pulleys. C. L. Redfield. Discusses the causes of waste of power in belt transmission and shows how choice of proper sizes of pulleys, and belt speeds, together with judicious opposing of strains, will enable large economies to be effected. 4500 w. Engineering Magazine—Jan., 1898. No. 17400 B.

Cost Keeping.

Cost Keeping Methods in Machine Shop and Foundry. Henry Roland. Devoted to problems of general expense and the determination of selling prices, showing the methods of leading American shops. 3500 w. Engineering Magazine—Jan., 1898. No. 17398 B.

Method of Keeping Weekly Shop Costs. W. N. Moore. Gives a plan of recording labor and material costs which has been in use for some years and found to be accurate, direct, and inexpensive. 1300 w. Ry & Engng Rev—Dec. 18, 1897. No. 17238.

Drop Hammer.

The Largest Drop Hammer in the World. Illustrated description of what is probably the largest specimen of this type of tool in existence, made for and by the Billings & Spencer Company, of Hartford, Conn. 1800 w. Ir Age—Dec. 30, 1897. No. 17469.

Flanges.

The Attachment of Flanges to Pipes. (Befestigung von Flanschen an Leitungsröhren.) Describing a form of roller expanding tool for securing flanges to copper steam pipes. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 13, 1897. No. 17328 D.

Gear Cutting.

The Fellows Gear Shaper. Illustrated description of a new machine and a new system for cutting gears. 2800 w. Am Mach—Dec. 9, 1897. No. 17054.

Grinding.

A Rational Construction of Mill with Metallic Grinding Surfaces. (Sur la Construction des Moulins à Meules Métalliques.) The mill constructed by M. Schweitzer, has channeled grinding surfaces revolving in a horizontal plane, similar to burr millstones, and is claimed to be superior to the roller mill. 600 w. Comptes Rendus—Nov. 29, 1897. No. 17321 D.

Hoisting Machinery.

See Elecrical Engineering, Power.

Ingot Mold.

A New Form of Ingot Mold for Casting Brass or Bronze Ingots, with Remarks on the General Form of Ingots. Erwin S. Sperry. Illustrated description. 1700 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16961 D.

Loom.

The Joubert Loom and Warp Beam. (Le Métier Mécanique et l'Ourdissoir, Système Joubert.) The improved Joubert loom, for weaving ribbons, velvets and other fine fabrics is able by reason of its positive movements, and mechanical perfection to produce the highest grade of work at a rate of 40 to 50 per cent. faster than ordinary looms, and is coming into extensive use in Lyons. 2500 w. 1 plate. La Revue Technique—Nov. 25, 1897. No. 17309 D.

Lubrication.

On the Theory of Lubrication and the Determination of the Thickness of the Film of Oil in Journal Bearings. F. L. O. Wadsworth. Brief review of a paper on this subject by Prof. Osborne Reynolds, published in the *Transactions of the Royal Society*, with additional notes

from experiments and study by the writer. Ill. 5500 w. Jour Fr Inst—Dec., 1897. Serial. 1st part. No. 17095 D.

Practical Experience in the Use of Lubricants. (Erfahrungen über die Praktische Verwendung der Schmiermitttel in der Technik.) Dr. Koller. Discussing the effects of temperature, composition and conditions of use upon the effective lubrication. 2500 w. Glaser's Annalen—Nov. 15, 1897. No. 17353 D.

Machine Tools.

Machine Tools in the Future. A tool-maker discusses the attitude of buyer to seller in England, making suggestions and aiming to influence buyers to depend on home manufacture. 1500 w. Engr, Lond—Dec. 17, 1897. No. 17421 A.

Pig Iron.

Scrap-Carrying and Pig-Iron Values. Translation of a paper by Dr. Wuest, read at meeting of German Foundrymen's Assn. Shows the present status of German foundry knowledge. 2000 w. Ir Trd Rev—Dec. 2, 1897. Serial. 1st part. No. 16981.

Pistons.

A Piston Pattern. G. H. Willard. Describes and illustrates a quick and cheap pattern and a successful way of molding. 400 w. Am Mach—Dec. 16, 1897. No. 17162.

Projectiles.

See same title under Mining and Metallurgy, Iron and Steel.

Rock Drills.

See Mining and Metallurgy, Mining.

Shop Driving.

See Electrical Engineering, Power.

Slide Rule.

The Slide Rule. A. H. Eldridge. How to make and use a slide rule. 1400 w. Mach, N. Y.—Dec., 1897. No. 17032.

Speed Indicator.

The Paragon Ball-Bearing Speed Indicator. Illustrated description of a device for counting the revolutions of anything the end of which is accessible, usually a shaft or spindle. 800 w. Am Mach—Dec. 2, 1897. No. 16984.

Steel Casting.

See same title under Mining and Metallurgy, Iron and Steel.

Time-Saving.

Time-Saving and Its Relation to Profits. Henry Hess. An analysis of methods for reducing costs, with consideration of an example under each method, and diagrams. 4200 w. Am Mach—Dec. 16, 1897. No. 17161.

Twist Drills.

Teachings of a Drill Factory. John Randol. Describes the manufacture of twist drills as carried on by the T. & B. Tool Co., of Danbury, Conn. Photographs of various steps of the process are given, and description of the fine work. 2800 w. Am Mach—Dec. 23, 1897. Serial. 1st part. No. 17274.

MISCELLANY.

Aerodynamics.

Gliding Experiments. Octave Chanute. A study of the laws underlying the possible solution of the problem of flight, with account of recent experiments and general information. Ill. 10500 w. Jour W Soc of Engs—Oct., 1897. No. 17086 D.

Artillery Mountings.

New Mountings for Coast Artillery. Abstract of a paper contributed by Sir George Clarke to the "Proceedings of the Royal Artillery Institution," describing new mountings devised to give speed. Ill. 2800 w. Engr, Lond—Dec. 17, 1897. No. 17420 A.

Automobiles.

A Year's Progress in Motor Road Vehicles in Great Britain. A general survey of the results with description of some of the more noticeable productions, and systems introduced. Ill. 7000 w. Ind & Ir—Dec. 3, 1897. No. 17151 A.

Radius of Action of Electric Motor Carriages. Hiram Percy Maxim, in *The Horseless Age*. An account of a satisfactory trip in a Columbia carriage of the Pope Manufacturing Company. 2400 w. Sci Am Sup—Dec. 11, 1897. No. 17065.

Road Motors in France. Editorial on the experiments made in France with the Scotte system of road traction, which is in effect a tramway without rails, with interesting features of the system. It has been working a year and seems to have proved its suitability for use under certain conditions. 2300 w. Engng—Nov. 26, 1897. No. 17007 A.

Self-Propelled Road Vehicles, 1896-97. W. Worby Beaumont. A paper read before the Liverpool Section of the Self-Propelled Traffic Assn. Reviews what has been accomplished in this field during the last year, especially in regard to heavy traffic, giving a list of British vehicles that have been brought out, with comments. 3500 w. Ind & Ir—Dec. 3, 1897. No. 17150 A.

The Competition of the Heavy-Weight Vehicles. (Concours des Poids Lourds.) The official report of the commission of the Automobile Club of France, with illustrations of the various vehicles, tables of weights, map and profile of the road, and full details of the performance of each automobile. Two articles, 20,000 w. 1 plate. Le Génie Civil—Nov. 20, 27, 1897. No 17303 G.

Twelve Months Continental Progress in Motor Road Vehicles. Brief review of progress giving the first place to France and merely mentioning work in Germany, Belgium and Italy. 1200 w. Ind & Ir—Dec. 3, 1897. No. 17152 A.

Bicycles.

A New Cycle Brake. Illustrated description of a brake that may be applied almost instantaneously without relaxing the grip. The invention of Horatio Phillips. 800 w. Engng—Nov. 26, 1897. No. 17014 A.

Some Lessons of the Stanley Show. Joseph Horner. Comments on the exhibits of ma-

chinery for bicycle-making being confined to American firms and discusses the reasons. 3000 w. Engng—Dec. 3, 1897. No. 17118 A.

The American Bicycle: Its Theory and Practice of Coutruction. Leonard Waldo. An interesting consideration of bicycle manufacture, especially the question of chain *versus* chainless driving. Discussion follows. 6000 w. Jour Soc of Arts—Dec. 3, 1897. No. 17096 A.

The Stanley Cycle Show. Comments on the features of the machines shown, and on points needing attention in the design of bicycles and in their use. 3000 w. Engng—Nov. 26, 1897. No. 17011 A.

Buckling.

Resistance to Buckling, in Theory, Experiment and Practice. (Die Knickfestigkeit in Theorie, Versuch und Praxis.) F. von Emperger. A mathematical investigation, comparing the various theories, and plotting the corresponding curves. Serial. Part I. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 3, 1897. No. 17342 B.

Cableway.

A Cableway Over Chilkoot Pass. Details of this work furnished by the Trenton Iron Co., of Trenton, N. J. 700 w. R R Gaz—Dec. 24, 1897. No. 17412.

Circulation.

The Circulation of Steam in Pipes. (Circulation de la Vapeur dans les Tuyaux.) A paper by M. Horsin-Déon, showing that vapors circulating in pipes do not readily mingle, but flow in layers or concentric masses. 1200 w. Moniteur Industriel—Nov. 20, 1897. No. 17391 F.

Cylindrical Bales.

A Machine for Making Cylindrical Bales. Illustrated description explaining the theory and construction of the press and its operation. 1500 w. Eng News—Dec. 16, 1897. No. 17177.

Flow.

Determination of the Velocity of Water in Pipes. (Bestimmung der Wassergeschwindigkeit in Druckleitungen.) A mathematical discussion showing the backward reaction upon the pipe and enabling the strength of anchorage to be computed. 1500 w. Schweizerische Bauzeitung—Oct. 30, 1897. No. 17365 B.

Great Gun.

A Great Coast-Defence Gun. G. L. Carden. Illustrated account of the largest gun ever constructed in the United States, now being made at the Bethlehem Iron Works. 3000 w. Harper's Wk—Dec. 11, 1897. No. 17063.

Ladders.

Tests of Ladders. George D. Rice. Illustrated account of tests recently made by writer, with testing machine used. 700 w. Eng & Min Jour—Dec. 25, 1897. No. 17295.

Matter.

The Manner of Changes in Matter. (Das Wesen Stofflicher Veränderungen.) An address by Prof. Klaudy, dealing with the molecular theories, and the relation of chemical, thermal and mechanical forces in the transformations of matter. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 10, 1897. No. 17343 B.

Motocycles.

Motocycles. For the purpose of developing a discussion on this subject a letter enclosing questions relating to the subject was sent out, and the results are given. Ill. 12500 w. Jour W Soc of Engs—Oct., 1897. No. 17083 D.

Paper Testing.

Normal Paper (Normal Papiere.) Tabulated data and results of tests of paper made by Prof. Herzberg at the Royal Testing Laboratory at Berlin. 10000 w. Mitt aus d Kgl Tech Versuchanstalt—Part V. 1897. No. 17378 F.

Radiation.

A Photographic Method of Recording Emissions of Heat. (Sur un Mode d'Enregistrement Photographique des Effluves Thermiques.) A memorandum by M. Guébhard, presented to the French Academy by M. Lippmann. By the use of a bath of diamido-phénol the heat radiation may be photographed in a manner similar to magnetic lines of force with iron filings. 1000 w. Comptes Rendus—Nov. 22, 1897. No. 17318 D.

Rope Tests.

The Influence of Length on Tests of Hemp Rope. (Ueber den Einfluss der Versuchslänge auf die Festigskeit von Haufseilen.) A paper by Prof. Rudeloff showing that the results depend upon the length of the test specimen, and to be comparable the specimens should be of equal length. 15000 w. Mitt aus d Kgl Tech Versuchsanstalt—Part V. 1897. No. 17379 F.

Stability.

Theory of the Stability of Locomotives. (Théorie de la Stabilité des Locomotives.) M. J. Nadal. A mathematical and geometrical analysis of the various movements of a locomotive engine considered as affecting the stability of the whole. 10000 w. Ann des Ponts et Chaussées—Part III. 1897. No. 17345 F+G.

Testing.

Experience with a New Machine for Testing Materials by Impact. S. Bent Russell. Defines resilience and studies its measurement, and modern methods of determining its value. Gives illustrated description of impact machine devised by the writer, and tests made with it, giving results and conclusions. 6300 w. Pro Am Soc of Civ Engs—Dec. 1, 1897. No. 17443 F.

Thermodynamics.

The Theta-Phi Diagram. Henry A. Golding. The theta-phi diagram shows, by its area, the proportion of heat utilized to the heat received. Comparison is made with the indicator diagram. 900 w. Prac Eng—Dec. 3, 1897. No. 17128 A.

The Variation of Energy in Isothermal Transformations. (De la Variation de l'Energie dans les Transformations Isothermes.) A mathematical investigation by M. Pellat presented to the French Academy by M. Lippmann, giving particular applications of the general formula of Clapeyron. 1200 w. Comptes Rendus—Nov. 8, 1897. No. 17316 D.

MINING AND METALLURGY.

COAL AND COKE.

American Coals.

The Calorific Value of American Coals. William Kent. A discussion of the paper of H. W. Lord and F. Haas, read at the Chicago meeting, Feb., 1897. 4400 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16960 D.

Anthracite.

The Heat-Value of Anthracite Small Sizes, and the Best Methods of Burning Them. Albert C. Leiseuring. Read at a meeting of the Anthracite Coal Operators' Assn., New York. Practice favors an under-grate forced blast, usually by fan or steam jet. A large grate area is essential. 1200 w. Col Guard—Nov. 26, 1897. No. 17024 A.

British Coal.

The British Coal and Coke Industries for 1897. A review of the output, exports, prices and conditions for 1897. 3500 w. Ir & Coal Trds Rev—Dec. 17, 1897. No. 17459 A.

Coal Cutting.

Electric Coal-Cutting Machinery. (Schlitz- und Schrämmaschine mit Elektrischem Antriebe.) Schaub's electric coal cutter consists of a number of parallel boring tools driven by chain connection to electric motors. 2500 w. 1 plate. Oesterr Zeitschr f Berg-u Hüttenwesen—Dec. 11, 1897. No. 17376 B.

Mechanical Appliances for the Getting of Coal. Ernest Kilburn Scott. The first of a series of articles which will describe and illustrate the more important coal-cutting machines in use in England and other countries. 1500 w. Ir & Coal Trds Rev—Dec. 10, 1897. Serial. 1st part. No. 17207 A.

Coal Getting.

Coal Getting without Blasting. Edwin Cottam. Read before the South Wales Institute of Engineers. A description of the construction and method of working of a machine which the writer calls the "up wedge" intended for wedging down coal, shale or soft stratified rock. Ill. 1800. Ir & Coal Trds Rev—Dec. 10, 1897. No. 17208 A.

Coal Industry.

Technical Progress of the Coal Industry in 1897. Considers the improvements in explosives, shipment, lighting, mining work, shaft sinking, &c. 5500 w. Ir & Coal Trds Rev—Dec. 17, 1897. No. 17456 A.

Coal Supply.

The Coal Supply of the United Kingdom. Leonard H. Courtney. Substance of presidential address before the Royal Statistical Society. Tracing from facts of recent experience, confirmation of the anticipations of Jevons as published in his book, *The Coal Question*, thirty years ago. 3300 w. Col Guard—Dec. 17, 1897. No. 17416 A.

Coke Manufacture.

Possible Economies in the Manufacture of Coke. Editorial urging the adoption of by-product coke ovens in England, and showing their economy. 1700 w. Ir & Coal Trds Rev—Nov. 19, 1897. No. 16931 A.

Coking.

Coking on a Bee-Hive Oven. William B. Phillips. Reports personal observations of the progressive changes that take place in a bee-hive oven from the moment of charging the coal to the withdrawal of the coke. 1400 w. Eng & Min Jour—Dec. 18, 1897. Serial. 1st part. No. 17183.

Disturbances.

Some Local Disturbances in Anthracite Collieries. Hobt. Huxham. Read before the South Wales Inst. of Engineers. Instances of disturbances arising from the folding of the strata and the difficulties contended with. 3000 w. Col Guard—Dec. 10, 1897. No. 17233 A.

East Durham, Eng.

The East Durham Coalfield. From the *Newcastle Chronicle*. Report of the condition of the coal trade in this district, which has seriously felt the recent depression. 1400 w. Col Guard—Nov. 19, 1897. No. 16920 A.

Screening.

The Development of Screening Apparatus. G. Schwidtal. From a communication to *Glückauf*. Illustrated description of the advances made, and explanation of the causes that led to them. 600 w. Col Guard—Nov. 26, 1897. No. 17022 A.

Syndicate.

A Collier's Syndicate. History of the Associated Colliers of Rive-de-Gier. The attempt resulted in failure but is of interest especially at the present time. Condensed from account in *Annales des Mines*. 2800 w. Col Guard—Dec. 10, 1897. No. 17232 A.

COPPER.

Copper Assay.

The Electrolytic Assay as Applied to Refined Copper. Discussion of paper of George L. Heath read at Lake Superior meeting, July, 1897. 3500. Trans Am Inst of Min Engs—Nov., 1897. No. 16959 D.

GOLD AND SILVER.

Ararat.

Neglected Goldfields. William Bradford. Part first gives some information of the Ararat goldfield in Australia. 800 w. Aust Min Stand—Nov. 4, 1897. Serial. 1st part. No. 17129 B.

Auriferous Lodes.

The Genesis of Certain Auriferous Lodes. John R. Don. A valuable condensed paper, giving original work, with tabulated results. Ill. 25000 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16962 D.

California.

A "Pocket" Horizon in Trinity County, California. Oscar H. Hershey. Describes the

geology of this region and the conditions governing the distribution of the gold "pockets." 1600 w. Min & Sci Pr—Dec. 11, 1897. No. 17179.

Chlorination.

The Modern Gold Chlorination Process for the Treatment of Gold Ores. John E. Rothwell. Illustrated description of the barrel chlorination process and its application. 11000 w. Min & Sci Pr—Dec. 18, 1897. No. 7297.

Cyanid Process.

The Cyanid Process for Gold Ores in Western America. Thomas Tonge. Reviewing the development of the process in America, and showing the importance of testing the ores with proper skill before assuming the process to be suitable. The necessity of skilled supervision is also emphasized. 3500 w. Engineering Magazine—Jan., 1898. No. 17401 B.

The Treatment of Slimes in the Transvaal. (Traitement des Slimes au Transvaal.) A review by M. Schiff, of J. R. Williams' paper on the electrical treatment of cyanid slimes by the Siemens and Halske method. 3000 w. Le Génie Civil—Nov. 13, 1897. No. 17302 D.

Dredge.

A New Form of Dredge for River-Bed Placers. J. M. Sweeney. Describes a proposed method for cleaning up the bedrock of streams containing gold deposits which claims to overcome the objections to known methods, and can also be used for any deposit of gravel or sand. Ill. 1600 w. Eng & Min Jour—Dec. 25, 1897. No. 17293.

Gold Production.

The Production of Gold Since 1850. Edward Sherwood Meade. A discussion of this subject aiming to explain why an increase in value of this commodity is not accompanied by an increasing production. Reviews improvements in mining, considers the future of gold, and its production in various countries. Also appendix. 8000 w. Jour Pol Econ—Dec., 1897. No. 17288 F.

Klondike.

The Latest News from the Klondike-Yukon Country. John D. McGillivray, in the *New York Herald*. Extracts from letters sent from this region reporting the hard conditions of labor, and the doubtful prospects. 2000 w. Eng & Min Jour—Dec. 11, 1897. No. 17102.

The Relief of the Klondike. Perry F. Nursey. Reviews the situation in this district, and explains the works intended to be undertaken by the North-western Trust and Development Company of America. 1700 w. Ind & Ir—Nov. 19, 1897. No. 16911 A.

Ontario.

An Epidemic of Mismanagement. Horace V. Winchell. A discussion of the mistakes made in the management of the Rainy River district in western Ontario. 1600 w. Can Min Rev—Nov., 1897. No. 17033 B.

The Michipicoton Mining District in Ontario. Wilson B. Cue. History of the discovery of this field, with description of the region, and general information. 2000 w. Eng & Min Jour—Dec. 25, 1897. No. 17296.

Placer Mining.

Placer Mining on Wheels. J. M. Sweeney. Illustrated description of a machine to recover gold from placer beds by washing all the gravel. 1800 w. Ry & Engng Rev—Dec. 18, 1897. No. 17241.

Placers.

A Mountain Placer. Arthur Lakes. Description of a placer located high in the mountains of Colorado, near Breckenridge. Discusses the points to be considered in making an estimate of a placer's value, the natural features that bear on its value, and veins sometimes discovered in working a placer. Ill. 2000 w. Mines & Min—Dec., 1897. No. 17169 C.

Prospecting.

Border Prospecting. Stanley Hunter. Report to the Victorian Secretary for Mines, upon the work done on the Victorian side of the frontier in prospecting the border country between Cape Howe and Forest Hill. 2800 w. Aust Min Stand—Nov. 4, 1897. No. 17130 B.

Smelting.

Matte Smelting at the Hall Mines, British Columbia. Robert R. Hedley. Brief illustrated description of what is probably the largest furnace of its kind. 500 w. Eng & Min Jour—Dec. 11, 1897. No. 17101.

Statistics.

Gold and Silver (Gold und Silber.) A review of the relative production of gold and silver from 1871 to 1897, with charts of production by years and countries. 2000 w. Two plates. Glückauf—Dec. 11, 1897. No. 17372 B.

Utah.

The Highland Bay Mine and Mill, Bingham, Utah. Describes this mine which yields two distinct ore bodies, one carrying gold and silver, the other copper, gold and silver. Also illustrated description of mill. 1700 w. Eng & Min Jour—Dec. 4, 1897. No. 17037.

IRON AND STEEL.

Apollo Works.

The Apollo Iron and Steel Company's Works at Vandergrift. Franklin Hilton. Illustrated detailed description of a plant in the United States, for the production of sheets. 2000 w. Ir & Coal Trds Rev—Dec. 3, 1897. No. 17123 A.

Armor.

British, French and German Armor. A comparison of thick armor recently tested. Ill. 1900 w. Engr, Lond—Nov. 19, 1897. No. 16916 A.

The Armor Plate Question. A summary of American armor-plate history down to the present time. 5000 w. Bul Am Ir & Steel Assn—Dec. 20, 1897. No. 17182.

The Armor Plate Report. A full abstract of the report presented to the Secretary of the United States Navy, by the Naval Armor Factory Board. 7500 w. Ir Age—Dec. 9, 1897. No. 17056.

Blast Furnaces.

Increasing Blast Furnace Capacity. Tabulated information of the blast furnaces of the United States, with editorial. Shows the number of furnaces to have decreased greatly, while the weekly capacity has increased. 2000 w. Am Mfr & Ir Wld—Dec. 10, 1897. No. 17105.

Notes on Six Months Working of Dover Furnace, Canal Dover, Ohio. Arnold K. Reese. A statement of unusual results obtained during a period of six consecutive months, giving conditions and figures. Ill. 1800 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16958 D.

Chicago.

The Chicago Iron Trade in 1897. George W. Cope. A review of the leading features of the trade, tracing the improvement by months, and giving statistics of pig iron, finished iron and steel, rails, &c. 4500 w. Ir Age—Dec. 30, 1897. No. 17470.

Forgings.

Steel Forgings. A discussion held Oct. 6, 1897, in connection with the Society's visit to the Bethlehem Iron Works, in its "Excursion to the East" in September, 1897. 4000 w. Jour W Soc of Engs—Oct., 1897. No. 17085 D.

Great Britain.

The British Iron and Steel Industries in 1897. General review of the condition of these industries, giving the furnaces in blast, exports, wages, &c. 3000 w. Ir & Coal Trds Rev—Dec. 17, 1897. No. 17460 A.

Iron Ore.

The Iron-Ore Supply. John Birkinbine. Interesting review of statistics of production in the United States and other countries. 3300 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16952 D.

Ironworks.

Davey, Paxman and Company's Works, Colchester. Illustrated account of these noted works, noticing special features observed on a recent visit. 2000 w. Engr, Lond—Dec. 10, 1897. Serial. 1st part. No. 17230 A.

Japan.

Japan as a Producer of Iron. Irvin McDowell. The scheme of Japan for making her own iron, steel and rails is discussed, with some of the difficulties she must overcome. 1000 w. Ir Trd Rev—Dec. 2, 1897. No. 16980.

Magnetic Ore.

The Preparation of Phosphoretted Magnetite at Lulea, Sweden. (Die Aufbereitung Phosphorreicher Magnetite in Lulea.) The magnetic ore is separated from the apatite after crushing, by means of electro-magnetic separators. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 13, 1897. No. 17327 D.

Marquette Range.

The Marquette Range.—Its Discovery, Development and Resources. James E. Jopling. Interesting history of this valuable iron-range. Ill. 4000 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16956 D.

Mesabi Range.

Explorations in the Mesabi Range. E. J. Longyear. The mode of occurrence and methods of work are explained. 2000 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16953 D.

Mining Methods on the Mesabi Range. C. E. Bailey. A résumé of methods of mining in this region. The ore is a soft hematite, and the two systems of operating are the stripping or open pit, and the underground system. 3000 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16957 D.

Philadelphia.

The Philadelphia Iron Market. Thomas Hobson. A review of the year 1897, with tabulated statements, and general information. 2500 w. Ir Age—Dec. 30, 1897. No. 17471.

Pig Iron.

See Mechanical Engineering, Shop and Foundry.

Pittsburg.

The Pittsburg Iron Trade in 1897. Robert A. Walker. A summary of the trade for the year, the special features, and review of different classes of work. 6500 w. Ir Age—Dec. 30, 1897. No. 17473.

Projectiles.

American Armor-Piercing Projectiles. Drawings of some of the latest designs of projectiles for which contracts have been recently awarded by the United States with official particulars of the requirements and tests specified. 2000 w. Engr, Lond—Nov. 19, 1897. No. 16917 A.

Steel Casting.

Steel Casting in Vacuum. A description of the Ellis-May process, with drawings and details; also a consideration of the practical results that must follow. 4500 w. Ir & St Trds Jour—Dec. 4, 1897. No. 17237 A.

Steel Works.

The Braeburn Steel Works. An account of the organization and opening of new works near Pittsburgh, with description and plan. 1300 w. R R Gaz—Dec. 3, 1897. No. 16969.

The Maryland Steel Company. Illustrated detailed description of the interesting plant at Sparrow's Point, Md. 2800 w. Ir Age—Dec. 9, 1897. No. 17055.

The Steel Works of the Glasgow Iron and Steel Company. Illustrated detailed description of one of the largest and best known concerns of its kind in Scotland. 3500 w. Ir & Coal Trds Rev—Nov. 19, 1897. No. 16930 A.

Stress.

Thermal Condition of Iron and Steel under Stress, and Measurement of Stress by Means of Thermo-Electricity. C. A. P. Turner. A discussion of the method of determining the stress in metal by measurement of the heat gained or lost when the stress is applied. 4800 w. Pro Engs' Soc of W Penna—Sept., 1897. No. 17-442 F.

Wrought Iron.

Experiments on Melting Wrought Iron. K. K. An account of experiments made to find a

cheaper method than the use of the Nobel furnace. 1800 w. Am Mach—Dec. 23, 1897. No. 7276.

MINING.

Blasting.

Electric Blasting. William Maurice. Abstract of paper read at meeting of the Chesterfield and Midland Counties Inst. of Engineers, Nottingham, Eng. Discusses low and high tension fuses, selection of igniters and detonators. 1800 w. Ir & Coal Trds Rev—Dec. 17, 1897. No 17458 A.

Experiments with Oxy-Hydrogen for Mine Blasting. From a communication by Bergassessor Heise to *Glückauf*. Describes experiments with cartridges containing a compressed mixture of oxygen and hydrogen, which are ignited by an electric spark. 1100 w. Col Guard—Dec. 10, 1897. No. 17234 A.

Centrifugal Fan.

The Theory of the Centrifugal Pump and Fan. C. H. Innes. Read before the North-East coast Inst. of Engineers and Shipbuilders. Discussion of this theory and the proper design of such pumps and fans. 2800 w. Col Guard—Dec. 10, 1897. Serial. 1st part. No. 17236 A.

Electric Hauling.

See Electrical Engineering, Power.

Fire Damp.

Explosives and Firedamp in England. (Les Explosifs et le Grisou en Angleterre.) A review of the experiments made by the English committee on flamelesss explosives, with illustrations of the testing plant at Hebburn, England. 4000 w. Le Génie Civil—Nov. 13, 1897. No. 17300 D.

The Walcher "Pneumatophor." (Der von Walchersche "Pneumatophor.") An apparatus for enabling explorations to be made in mines containing irrespirable gases. The same air is used again and again, the carbonic acid being absorbed by caustic soda, and fresh oxygen supplied. 5000 w. Glückauf—Dec. 4, 1897. No. 17371 B.

Improvements.

Improvements in Mine Plant, Westphalia. M. Robiaud. From a communication to the Société de l'Industrie Minérale, Saint-Etienne. Observations on ropes and winding engines, with illustrations. 3800 w. Col Guard—Dec. 3, 1897. No. 17156 A.

Improvements in Mining and Metallurgical Appliances during the Last Decade. E. Gybbon Spilsbury. Reviews the many and various improvements made in the last ten or twelve years which have resulted in increase of out-put and lessening of cost. 5500 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16951 D.

Mine Titles.

Acquisition of Mines by Adverse Possession. An explanation of English law relating to titles of mines or quarries. 2700 w. Col Guard—Dec. 17, 1897. No. 17415 A.

Mining Laws.

The Proposed Revision of the Mining Laws. Full text of the report of the sub-committee of the International Gold Mining Convention at Denver. 3500 w. Eng & Min Jour—Dec. 4, 1897. No. 17038.

Regulation Act.

Queensland Mines Regulation. A summary of some of the recommendations made by the Royal Commission, appointed to report on the laws relating to mining for gold and other minerals. 1200 w. Col Guard—Dec. 3, 1897. No. 17154 A.

Review.

Review of Recent Progress in the Mining Industry. (Revue des Progrès de l'Industrie Minière.) M. Leproux. Especially devoted to recent improvements in machinery and methods in all parts of the world, with many illustrations. 10000 w. Bulletin de la Société d'Encour—Nov., 1897. No. 17348 F + G.

Rock Drills.

The Plant and Product of the Ingersoll-Sergeant Drill Co. Charles W. Melcher. History of the company and description of the plant and the class of machinery manufactured by them. Ill. 3000 w. Jour W Soc of Engs—Oct., 1897. No. 17084 D.

Safety Lamp.

Laune Re-lighting Safety Lamp. From a report by M. G. Chesneau, to the French Firedamp Commission, published in the *Annales des Mines*. Illustrated description, with report of trials, and the advantages and disadvantages. 1200 w. Col Guard—Nov. 19, 1897. No. 16923 A.

The First Safety Lamps. William Clifford. Sequel to an article that appeared in this paper in Jan., 1897. The Davy lamp and some of the improvements which have been attempted upon it. 3500 w. Mines & Min—Dec., 1897. No. 17172 C.

Salt Mining.

The Extension of the Wolfdietrich Tunnel. (Die Erweiterung des Wolfdietrichstollens.) Describing the work upon a deep tunnel in the Salzburg salt mines. Electric machinery driven by hydraulic power was used, including the Siemens' rock drill. 6000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 13, 1897. No. 17374 B.

Steam Power.

Economizing Steam Power at Mines. From an abstract for the Societé de l'Industrie Minérale, of a report, published in the *Zeitschrift für das Berg-Hütten und Salinenwesen*, by R. Zörner, on the saving he effected in the power required for working the Royal König collieries, near Neunkeirchen. 2300 w. Col Guard—Nov. 26, 1897. No. 17021 A.

Surveys.

Mine Maps and Surveys. Selwyn M. Taylor. Abstract of paper read before the Western Pennsylvania Central Mining Institute. Briefly describes how a mine survey should be made. 600 w. Am Mfr & Ir Wld—Dec. 24, 1897. No. 17436.

Transportation.

Notes on Mining and Transportation. Harry J. Lewis. Read before the Western Pennsylvania Central Mining Institute. Showing how closely allied are these two industries. 1500 w. Am Mfr & Ir Wld—Dec. 24, 1897. No. 17435.

U. S. Mining Law.

The Proposed Revision of the United States Mining Law. R. W. R. Editorial criticism of the resolutions presented by W. S. Keyes, and the propositions of Mr. Freeland. 1800 w. Eng & Min Jour—Dec. 11, 1897. No. 17100.

MISCELLANY.

Carbides.

A New Method of Preparing Carbides. (Nouvelle Méthode de Préparation des Carbures.) A paper by M. Moissan before the French Academy upon the preparation of metallic carbides by the action of carbide of calcium upon the corresponding oxides. 1500 w. Comptes Rendus—Nov. 29, 1897. No. 17320 D.

Diamond Fields.

The Development of the South African Diamond Fields. H. S. Canby. A study of the development of these mines. Part first deals principally with the alluvial or placer mines and dry diggings, giving interesting information, 2500 w. Yale Sci M—Nov., 1897. Serial. 1st part. No. 16933 C.

Graphite.

Graphite in Siberia. R. Helmhacker. Information of the discovery and working of these valuable deposits of graphite, which rank among the richest and most promising in the world. 1500 w. Eng & Min Jour—Dec. 25, 1897. No. 17294.

Mica.

Mica—Its Uses and Appliances. Treats of the peculiarities of this mineral and its general uses. 1300 w. Can Min Rev.—Nov., 1897. No. 17034 B.

Petroleum.

The Development of the Russian Petroleum Industry. (Die Entwicklung der Erdöl Industrie in Russland.) A general review of the past 30 years with commercial statistics from official reports. Three articles. 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 27, Dec. 4, 11, 1897. No. 17375 G.

Phosphates.

The Phosphate Mines of South Carolina. George Leighton. A description of the peculiar deposits and the methods of mining, with a history of their discovery; the nature of the rock, its appearance, and some of the theories in regard to the animal life from which it was originally formed. 3500 w. Mines & Min—Dec., 1897. No. 17171 C.

Sweden.

The Mining and Metallurgical Industries of Sweden as Shown at the Stockholm Exhibition. Bennett H. Brough. Interesting account with excellent description of exhibits in the departments named. Also discussion. Ill. 10,000 w. Jour Soc of Arts—Dec. 10, 1897. No. 17190 A.

Testing.

Metallography as a Testing Method. F. Osmond. Enumerates methods for distinguishing the components. 1800 w. Am Mfr & Ir Wld—Dec. 3, 1897. Serial. 1st part. No. 17036.

Tin.

Chinese Tin Smelting. Frank Owen. Extract from a paper on "Mining in Perak," read before the Inst. of Mining and Metallurgy, London. Describes their system as carried out in a blast furnace. 1400 w. Col Guard—Nov. 19, 1897. No. 16921 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene. Vivian B. Lewes. Abstract of a lecture delivered at the London Institution. Reviews the history of the commercial formation of calcic carbid, describes the process of manufacture, the apparatus for generating acetylene and the difficulties in its utilization. 2800 w. Jour of Gas Lgt—Nov. 30, 1897. No. 17061 A.

The Technical Analysis of Calcium Carbid and Acetylene and the Purifying of the Latter. G. Lunge and Edward Cedercreutz. From the *Zeitschrift für Angewandte Chemie.* Gives the method proposed by the authors to determine analytically, the possible 4 per cent. of impurities in acetylene. 2000 w. Pro Age—Dec. 15, 1897. No. 17168.

Use of Acetylene for Enriching Gas Produced from Lean Coals. Th. Vautier. Presented at the convention of the "Société Technique de de l'Industrie du Gaz." Describes a series of tests upon coals which produce a gas having a yield of less than 3.6 cubic feet per carcel hour, or .5 cubic feet per candle hour. 3300 w. Pro Age—Dec. 1, 1897. No. 16946.

Ammonia.

Sulphate of Ammonia. E. A. Harman. Read before the Manchester District Institution of Gas Engineers. The various methods for the disposal of ammoniacal liquor are reviewed, with methods and systems adopted for making use of waste gases and recovering other by-products. Discussion follows. Ill. 5200 w. Jour Gas Lgt—Nov. 30, 1897. No. 17059 A.

Coal Gas.

On a Coal Gas Element. Dr. W. Borchers. Read before the Verb. Deutsch. Electrotechniker. A description of the investigations made and apparatus used. Ill. 1600 w. Elec Eng, N. Y.—Dec. 23, 1897. No. 17262.

Some Recently Discovered Constituents of Coal Gas. Discusses the views of Berthelot and of P. Fritzeche, and the limited study that

has been given the subject. 1200 w. Jour Gas Lgt—Dec. 7, 1897. No. 17218 A.

Distribution.

Mr. D. Coats Niven on Gas Distribution. J. Skinner. A criticism of views advanced by Mr. Niven. 1600 w. Jour of Gas Lgt—Dec. 7, 1897. No. 17219 A.

Fires.

Gas as a Cause of Fires. Facts taken from a paper by A. Müller, published in the *Journal für Gasbeleuchtung*, proving gas one of the safest illuminants. 900 w. Jour of Gas Lgt—Nov. 30, 1897. No. 17057 A.

Florida.

Some Random Notes on Florida Gas Works. A few notes concerning the plants and their operation. 1900 w. Am Gas Lgt Jour—Dec. 13, 1897. No. 17097.

Gas Bills.

X-Rays on the Gas Bill. An explanation of the method of meter reading and making of charges, with the aim of removing the distrust and misunderstanding of the general public. 3300 w. Am Gas Lgt Jour—Dec. 6, 1897. No. 17035.

Gas Composimeter.

Principle of the Gas Composimeter. Edward A. Uehling, in the *Stevens Indicator* The apparatus is based on the laws governing the flow of gas through small apertures. Explains the means of fulfilling the necessary conditions, and gives autographic records taken. Ill. 2200 w. Pro Age—Dec. 1, 1897. No. 16947.

Gas Stoves.

The Determination of the Efficiency and Loss of Heat in Gas-Stoves. Abstract translation of article by F. Haber, in *Journal für Gasbeleuchtung*. Gives a method for the estimation of the duty of a gas stove, much more simple than the methods in general use. 2000 w. Jour Gas Lgt—Dec. 14, 1897. No. 17272 A.

Gas Works.

The Proposed new Site for the Edinburg and Leith Gas-Works. Reports of W. R. Herring and G. Livesey. 2500 w. Jour of Gas Lgt—Dec. 14. 1897. No. 17273 A.

Hydraulic Mains.

The Work of the Hydraulic Main and Condenser. S. Carpenter. Explains the working of the wet main and what the writer has found best in his experience. 2000 w. Jour of Gas Lgt—Dec. 7, 1897. Serial. 1st part. No. 17220 A.

Incandescent Mantles.

Some Tests on Incandescent Gas Mantles. E. A. Medley. Gives tests made in 1893 on one of the old A form of Welsbach burner, and on a group of five C burners, with recent tests on several makes of "mantles" which can be bought in England and in Germany. 1800 w. Elec Rev, Lond—Dec. 10, 1897. No. 17214 A.

Philadelphia Gas.

Municipal Gas in Philadelphia. John I. Rogers. The article contains the substance of a study made by the writer concerning the published statement of Mr. Dolan, that the works had been run at a loss for three years. A paper of interest in determining whether Philadelphia's municipal experiment was a failure. 6000 w. Munic Affairs—Dec., 1897. No. 17449 C.

The Philadelphia Gas Lease. Frederic W. Speirs. Gives the history of the gas franchise in this city, and discusses the terms of the lease, claiming that it proves nothing but the power of aggregated capital in politics. 4600 w Munic Affairs—Dec., 1897. No. 17448 C.

Retorts.

Billington's Patent Method of De-scurfing Gas Retorts. S. S. Mellor. Read before the Manchester District Institution of Gas Engineers. Describes a method which has given satisfaction at the Longport Gas Works, and is applicable to any works. Discussion. 2300 w. Jour of Gas Lgt—Nov. 30, 1897. No. 17060 A.

Retort Setting and Retort Heating. F. D. Marshall. A letter to the editor making objections in some respects to the system advocated by Mr. Carpenter in a paper recently published. 1700 w. Gas Wld—Nov. 27, 1897. No. 17001 A.

The Bronder Improved Apparatus for Discharging Retorts. Illustrated description as given in the specification. 3600 w. Am Gas Lgt Jour—Dec. 27, 1897. No. 17434.

Small Gas-Works.

The Application of Chemistry in the Management of Small Gas-Works. Suggestions of methods and description of tests that may be of use to a manager who is not a chemist. 2000 w. Jour of Gas Lgt—Nov. 23, 1897. No. 16972 A.

Water Gas.

Coal Gas or Water Gas? Abstract of a paper on recent progress in water-gas lighting by Dr. Strache, with criticism by E. Körting. Translated from *Journal für Gasbeleuchtung*. 1300 w. Gas Wld—Nov. 20, 1897. No. 16926 A.

Welsbach.

Proposed Amalgamation of the Welsbach Companies. Indicates the scope of the scheme, and reports its adoption. 2000 w. Gas Wld—Nov. 27, 1897. No. 17002 A.

The Original Welsbach Patent. Translated extract from the specifications of the original patent with much valuable information. 5800 w. Pro Age—Dec. 15, 1897. No. 17,167.

SEWERAGE.

Baltimore, Md.

Baltimore Sewerage Plans. A sewerage commission has recommended the construction of sewers costing about $10,500,000. Describes the conditions existing and the system adopted. 2000 w. Eng Rec—Dec. 18, 1897. No. 17186.

Cleveland, Ohio.

Walworth Run Sewer, Cleveland, O. A circular sewer of concrete and brick on an oak grillage was built under difficult conditions by methods described. 1000 w. Eng Rec—Dec. 18, 1897. No. 17187.

River Purification.

The Purification of the Thames. William Joseph Dibdin. Abstract of paper from Pro ceedings of the Institution of Civil Engineers, (England) Vol. CXXIX. Considers the work of effecting the purification of the sewage, in freeing the river from this pollution, and the best method of effecting further improvements. 2400 w. Jour W Soc of Engs—Oct., 1897. No. 17089 D.

Sewage Pumps.

The Pumping Engines of the Charlottenburg Sewage System. (Die Pumpmaschinen der Kanalisation von Charlottenburg.) Illustrated description of fine compound pumping engine on the Riedler system, at Charlottenburg, near Berlin, with plate of working drawings, and data of tests. 1000 w. 1 plate. Zeitschr d ver Deutscher Ing—Nov. 13, 1897. No. 17326 D.

Sewage Purification.

Sewage Disposal and Water Purification. Charles Francis. Urging action to prevent cities discharging their sewage into streams or water courses, and commending the methods of broad irrigation and intermittent downward filtration. 3500 w. Munic Engng—Dec., 1897. No. 16965 C.

Sewage Purification in Rural Districts. J. Aldersey Davenport. Advocates the use of intermittent downward filters. 1000 w. San Rec —Nov. 19, 1897. No. 16928 A.

The Purification of Sewage at Cologne. (Klärung der Kanalwässer der Stadt Köln.) Report of Prof. Fraenkel upon the best method of purification. Sedimentation is recommended in two pools alternately emptied and cleaned. 3500 w. Gesundheits-Ingenieur—Nov. 15, 1897. No. 17362 B.

The Purification of Sewage by Bacteria. Samuel Rideal. Explains the theory of the bacterial processes and gives an outline of the different methods. Discussion follows, 9500 w. Jour Soc of Arts—Dec. 17, 1897. No. 17451 A.

STREETS AND PAVEMENTS.

American Paving.

American Street Paving. Report of the committee of the American Society of Municipal Improvements, with letters and editorial. 5000 w. Eng Rec—Dec. 11, 1897. No. 17113.

WATER SUPPLY.

Boston, Mass.

Water Supply of Boston, Mass. Reports the danger of exhausting the water supply, and the precautions taken to guard against this, with other information of interest. 1000 w. Fire & Water—Dec. 25, 1897. No. 17437.

Buffalo, N. Y.

Buffalo Water-Works Intake Tunnel. Information relating to the construction of this tunnel, begun in July, 1895, and finished in Nov., 1897, at a cost of $90,000. 1200 w. Eng Rec —Dec. 18, 1897. No. 17185.

Contamination.

The Contamination of the Water Supply of Sauve. (Sur la Contamination de la Sourc e de Sauve.) The contamination of the water supply of this French town was traced by the appearance in the water of the reactions of fluoresceine, which had been placed in the suspected drains. 1000 w. Comptes Rendus—Nov. 29, 1897. No. 17322 D.

The Contamination of Wells. (Sur lar Contamination des Puits.) M. Duclaux. A note to the French Academy, showing dangers of well water, and the distance and nature of soil through which contamination occurred in a village in the Department of Cantal, France. 1200 w. Comptes Rendus—Dec. 6, 1897. No. 17324 D.

Field Work.

Investigations of Water-Supply. F. H. Newell. Description of the field-work carried on in various parts of the country. 3500 w. Trans Am Inst of Min Engs—Nov., 1897. No. 16955 D.

Impure Water.

An Insanitary Object Lesson. Perry F. Nursey. A statement of the negligence and ignorance displayed in the town of King's Lynn, Eng., and the typhoid epidemic resulting from it. 2200 w. Ind & Ir—Dec. 10, 1897. No. 17225 A.

The Pollution of Water and Its Correction. Reginald Empson Middleton. Read before the Society of Engineers, London. Considers generally the sources of pollution, discusses legislation on this subject in England, gives the writer's solution of the difficulty in dealing with sewage, &c. 3500 w. Ind & Ir—Dec. 10, 1897. No. 17226 A.

Landsberg.

The Waterworks of the City of Landsberg on the Wartha, Prussia. (Das Wasserwerk der Stadt Landsberg a. d. W.) With full details of wells, pumping station and distribution for this city of 30,000 inhabitants. Two articles. 1 plate. 5000 w. Gesundheits Ingenieur—Nov. 30, Dec. 15, 1897. No. 17363 E.

New York.

Water Supply of Greater New York. Reviews the present supply of the annexed districts and of the city, with some account of the bills to be introduced at the opening of the State legislature. 1200 w. Fire & Water—Dec. 18, 1897. No. 17196.

Pumping Engine.

See Mechanical Engineering, Engines.

Pumping Plant.

A Gasoline Pumping Plant for a Town Water Supply. Description of the plant installed at Gibsonburg, Ohio, giving the form of guarantee accepted. 1100 w. Eng News—Dec. 23, 1897. No. 17260.

Reservoir.

Construction of the Jerome Park Reservoir. Describes the site and plan of construction, with the work now being executed. 2400 w. Eng Rec—Dec. 4, 1897. No. 17040.

The Bogamdani Tank Restoration. Some interesting engineering details in connection with

this project are noted. 1000 w. Ind Engng—Oct. 30, 1897. No. 17004 D.

Water Mains.

Repairing a Water Main, F. G. Cudworth. Describes an unusual piece of work in the system of the Orange, Mass., waterworks, Ill. 400 w. Eng Rec—Dec. 11, 1897. No. 17114.

MISCELLANY.

Art.

Municipal Art. Frederick S. Lamb. Criticizes the attitude of the citizens of Greater New York to this subject, showing how money has been wasted, or improvements neglected until the work has become needlessly expensive; compares it with foreign cities; makes numerous suggestions. Ill. 6400 w. Munic Affairs—Dec., 1897. No. 17446 C.

Fire Alarm.

See Electrical Engineering, Telegraphy and Telephony.

Fire Danger.

See Architecture and Building, Construction.

Fire Risk.

See Electrical Engineering, Power.

Garbage.

Garbage and Refuse Disposal of Cities. Report of the Committee on Garbage and Refuse, of the American Public Health Assn. 4500 w. Munic Engng—Dec., 1897. No. 16966 C.

Lighting System.

Petroleum "Arc" Lighting. J. G. Dudley. Illustrated description of a lighting system which claims to give safety, simplicity and steadiness, with great brilliancy and economy. 3500 w. Pro Age—Dec. 1, 1897. No. 16948.

London Fire.

The Great City Fire. Editorial on the fire protection of London and the necessity of fire prevention. 1900 w. Engng—Nov. 26, 1897. No. 17423 A.

Police Service.

See Electrical Engineering, Telegraphy and Telephony.

Municipal Franchises.

Public Control, Ownership or Operation of Municipal Franchises. R. R. Bowker. Written from the point of view of the economist or citizen, with special references to electric lighting. Does not favor municipal ownership. 11000 w. Munic Affairs—Dec., 1897. No. 17444 C.

Municipal Lighting.

Municipal Electric Lighting. John R. Commons. A paper advocating municipal electric lighting, reviewing what has been accomplished, criticizing investigations made, and studying the subject in general. 14000 w. Munic Affairs—Dec., 1897. No. 17445 C.

New York.

Greater New York a Century Hence. George E. Waring, Jr. A brief forecast of future conditions, based on present tendencies. 2000 w. Munic Affairs—Dec., 1897. No. 17447 C.

Playgrounds.

City Playgrounds. Editorial on the necessity for municipal action in securing playgrounds in our large cities, with report of what has been done in Philadelphia, Boston and New York. 1700 w. Gar & For—Dec. 8, 1897. No. 17052.

Pleasure-Grounds.

Neighborhood Pleasure-Grounds in Boston. F. L. Olmsted, Jr. A description of these places of recreation and the special features for the healthful exercise of the people. Ill. 2300 w. Harper's Wk—Dec. 25, 1897. No. 17242.

Public Improvements.

Municipal Public Improvements and the Laws Governing Them. David Molitor. Presents a scheme for the organization of a board of public improvements as would best serve a municipality of from two to three hundred-thousand inhabitants. 2500 w. Munic Engng—Dec., 1897. No. 16964 C.

Refuse.

The Disposal of Towns' Refuse. W. M. Watson. Part first discusses the various kinds of refuse to be disposed of in towns, the manner of utilizing most of it, and the destruction furnace, the heat of which can be used for generating steam for power, &c. 2200 w. Can Eng—Dec., 1897. Serial. 1st part. No. 17099.

Sanitation.

Twenty Years' Sanitation in an Urban District. James Young. A résumé of the advancement in all matters pertaining to the public health of the district of St. George, Bristol, England, showing an interesting record of progress and development. 1800 w. San Rec—Nov. 26, 1897. No. 17003 A.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

China.

Railway Prospects in China. J. T. M. A summary of the arguments for and against the likelihood of rapid building. 1600 w. Ry Age—Dec. 17, 1897. No. 17194.

Leeds, England.

Railway Extension in the Leeds District. The improvements contemplated on the London and North-Western Railway, England. 600 w. Transport—Nov. 26, 1897. No. 17006 A.

Review.

Railway Construction in 1897 and 1898. A general review of the work for 1897, with enumeration of the more important lines added, those still under construction, and for which contracts have been let. 1700 w. Ry Age—Dec. 24, 1897. No. 17438.

Russia.

Railway Construction and Management in Russia. Extracts from the report of the British Consul at St. Petersburg, showing the wonderful progress in construction. 1000 w. Transport—Dec. 17, 1897. No. 17431 A.

Southern United States.

Southern Railroad Extensions. D. Allen Willey. An account of the new lines to be built which will aggregate 3000 miles, with a record of the railroad construction in the Southern States for the year 1897. 1500 w. Mfrs Rec—Dec., 1897. No. 17289.

Wales.

From London to South Wales Direct. An account of the new section of railway which will shorten the Great Western route. It is about 33½ miles in length and will cost a million sterling. The ceremony of cutting the first sod is reported. 1700 w. Transport—Dec. 3, 1897. No. 17158 A.

MAINTENANCE OF EQUIPMENT.

Armored Cars.

R. R. Arsenals and Burglar Traps. Arthur H. Giles. Illustrated descriptions of devices to protect cars from railway robberies. 1400 w. R R Car Jour—Dec., 1897. No. 17108.

Box Car.

Standard Ventilated Box Car—Louisville and Nashville R. R. Describes and illustrates a car of 60,000 lbs. capacity, adapted to the conveying of either ordinary or perishable merchandise. 1600 w. R R Car Jour—Dec., 1897. No. 17107.

Brakes.

The Chapsal Electro-Pneumatic Brake. George Leonard. Abstract of a paper before the Society of Civil Engineers of France. Also editorial. Description of the apparatus, principally in its application to the Westinghouse Automatic Air Brake. The editorial shows the futility of inventing apparatus for working the air-brake, and discusses the advantages claimed. 3800 w. R R Gaz—Dec. 24, 1897. No. 17411.

Car Heating.

Heating Passenger Cars. William Garstang. Abstract of a paper read at the November meeting of the Western Ry. Club. Traces the progress made, and discusses the systems in use, noting points that need special attention. 3000 w. Ry & Engng Rev—Dec. 25, 1897. No. 17299.

Carriage Lighting.

Railway Carriage Lighting and the Latest Experiments with Acetylene. From the *Zeitung des Vereins deutscher Eisenbahn-Verwaltungen.* Reports the experiments made by the Berlin firm of Messrs. Julius Pintsch, with criticisms and comments. 1800 w. Ry & Engng Rev—Dec. 4, 1897. No. 17044.

Coke Car.

80,000-pound Coke Car—Buffalo, Rochester and Pittsburgh Railway. Illustrated description. 500 w. Loc Engng—Dec., 1897. No. 16938 C.

Fireboxes.

See Mechanical Engineering, Boilers.

Freight Cars.

The Passing of the Wooden Freight Car. Editorial on the changes taking place in the construction freight equipment. 1300 w. Am Eng & R R Jour—Dec., 1897. No. 16983 C.

Freight Trains.

The Making Up of Freight Trains Partially Equipped with Air Brakes. Edward Grafstrom. States the prevailing custom and discusses whether or not it is the best. 1400 w. Eng News—Dec. 23, 1897. No. 17259.

Locomotives.

Bogie Tank Engine—London, Tilbury, and Southend Railway. The principal dimensions and weights with description of a powerful engine, with engraving and working drawings of large size. 1300 w. Engr, Lond—Dec. 17, 1897. No. 17422 A.

Brooks Consolidation Engine for the Mexican Central Railway. Illustration, dimensions and general particulars. 500 w. Loc Engng—Dec., 1897. No. 16940 C.

Computations for Compound Locomotives and their Steam Consumption. (Berechnung der Verbundlokomotiven und ihres Dampf-verbrauches.) A comparison of the compound and simple engine based upon indicator diagrams. A valuable mathematical paper by Inspector Leitzmann. Two articles. 8000 w. Zeitschr d ver Deutscher Ing—Nov. 27, Dec. 4, 1897. No. 17334 G.

Four-Cylinder Compound Locomotive for the London and North-Western Railway. Illustrated description with leading particulars of a new type of engine possessing features of interest. 800 w. Engng—Dec. 3, 1897. No. 17119 A.

Hand Starting Valve for Compound Locomotive. (Neuer Wechselkolben mit Handbewegung für Verbund-Lokomotiven.) Von Borries improved starting valve enables the engineer to convert the locomotive from compound to simple, and *vice versa*, at will. 1000 w. 1 plate. Glaser's Annalen—Dec. 1, 1897. No. 17356 D.

Mountain Express Locomotives. (Die Bergschnellzug Lokomotiven.) A general discussion of locomotives intended for heavy grades at fair speeds, with especial reference to the engines of the Austro-Hungarian and Italian railways in comparison with those of other countries. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 26, 1897. No. 17340 B.

New Experimental Locomotive "Schenectady No. 2," Purdue University. Illustrated detailed description with editorial. 2500 w. R R Gaz—Dec. 17, 1897. No. 17173.

The Gilderfluke Locomotive. Eli Gilderfluke. A humorous parody of the many complicated engines which have appeared from time to time. 3000 w. Loc Engng—Dec., 1897. No. 16937 C.

Trials of English Locomotives. Report of the trials of two English locomotives that were invited to remain in France after the closing of the Paris Exhibition of 1889, to run trial trips.

The leading dimensions are given, also editorial. 2800 w. Engr, Lond—Nov. 19, 1897. No. 16915 A.

Twelve-Wheel Locomotive for the Chicago and Eastern Illinois. Elevation and principal dimensions. 400 w. R R Gaz—Dec. 24, 1897. No. 17413.

Two New Geared Locomotives. Illustrated detailed description of the Heisler geared locomotive, and the Climax engine, with a discussion of the general question of geared locomotives, and the two classes into which they may be divided. Also editorial. 3800 w. Eng News—Dec. 9, 1897. No. 17069.

Lubrication.

Car and Locomotive Lubrication. Discussion of the paper presented by George W. Cushing. 10700 w. Pro West Ry Club—April, 1897. No. 17282 D.

Mineral Traffic.

Rolling Stock for Mineral Traffic. Illustrated description of the latest built cars used in the United States for this purpose, comparing the wooden and metal cars, the increase in size, &c. 1800 w. Ir & Coal Trds Rev—Dec. 17, 1897. No. 17457 A.

Repairs.

Charges for Repairs West of the 105th Meridian. George S. Hodgins. Discussion of differential charges. 1500 w. R R Car Jour—Dec., 1897. No. 17110.

The Cost of Locomotive Repairs and the Efficiency of Machine Tools in Railroad Shops. William Forsyth. Showing how to economize, taking into consideration the fact that the largest expense is for labor; and also pointing out how tools can be made to do more work. 3600 w. Pro West Ry Club—April, 1897. No. 17283 D.

Sleeping Cars.

Second-Class Sleeping Car Rates. Editorial on the movement toward second-class sleeping-car service and describing the tourist cars. 900 w. Ry Age—Dec. 17, 1897. No. 17193.

Steam Pressure.

The Limits ofSteam Pressure in Locomotives. G. R. Henderson. Outlines the probable limit of steam pressure in locomotives, and some of the difficulties in reaching and using such pressures. 1500 w. Am Eng & R R Jour—Dec., 1897. No. 16982 C.

Steel Cars.

Life of the Steel Car. Comments on the life of the steel car as compared with the wooden car, and the protection needed to prevent corrosion. 1100 w. R R Car Jour—Dec., 1897. No. 17106.

Swivel Truck.

The Busse Locomotive Swivel Truck. (Laufachseneinrichtung für Schienenfahrzeuge, Bauart Busse.) A form of single swivel axle to be used both forward and as a trailer for locomotives for use on sharp curves. 1200 w. Glaser's Annalen—Nov. 15, 1897. No. 17351 D.

The "Composite."

The "Composite" and Its Field. C. Peter Clark. Abstract of a paper read before the New England Railroad Club. Sets forth the advantages and qualifications of this car for certain uses. 2300 w. R R Gaz—Dec. 24, 1897. No. 17410.

Wagner Cars.

The Lake Shore Limited. Description and engravings giving an idea of the handsome appearance and conveniences of these cars, built for special service. 700 w. R R Car Jour—Dec., 1897. No. 17109.

MAINTENANCE OF WAY.

Curves.

Widening the Gage of Railway Track on Curves. William H. Searles. A study of the action of trucks and locomotives upon a curved track, showing that the widening is a simple mathematical problem. Also editorial. 3800 w. Eng News—Dec. 2, 1897. No. 16989.

Gage.

A Change to Standard Gage on the Columbia & Puget Sound Railroad. The method followed will be of interest to those interested in maintenance of way. 900 w. Ry & Engng Rev—Dec. 18, 1897. No. 17240.

Railroad Tracks.

Surfacing Railroad Track by Means of Compressed Air. Brief Description, with illustrations, of the method. 400 w. Compressed Air—Dec., 1897. No. 17280.

Rails.

Rails for the Eastern Chinese (Manchurian) Railroad. Illustrated description from the Government specification, of the style of rail and fastenings which have been adopted. 3000 w. R R Gaz—Dec. 10, 1897. No. 17091.

Superstructure.

The Superstructure of British Railways. (Les Voies des Chemins de Fer Anglais.) Comparing British and French railway construction, with sections of rails, chairs and joints used on the leading English railways. Two articles. 5000 w. 1 plate. Le Génie Civil—Nov. 27, Dec. 4, 1897. No. 17305 G.

Surveying.

Specifications for a Railroad Resurvey. G. W. Chance. Treats of general measurements, transit work, photographic survey, leveling, platting, etc. 2000 w. Ry & Engng Rev—Dec. 25, 1897. No. 17298.

Tunnel.

The Line of the Left Bank of the Seine. (La Ligne de la Seine. Rive Gauche.) Describes the tunnel along the left bank of the Seine at Paris, through which the Orleans Railway is to be brought to the new terminal station on the Quai d'Orsay; giving numerous sections of the tunnel at various points along the line. 2500 w. 1 plate. La Revue Technique—Nov. 25, 1897. No. 17310 D.

SIGNALING.

Block Signals.

Automatic Semaphore Block Signals on the Illinois Central. Illustrated description of these signals, with diagram of the electric circuits by which they are automatically moved. 2200 w. R R Gaz—Dec. 3, 1897. No. 16970.

The Application of Current Formulas to the Siemens Block System. (Die Stromlauf-Formeln und ihre Anwendung zur Schaltung Siemens'scher Blockwerke.) A mathematical investigation of the conditions of operation of the Siemens and Halske system of block signaling, with many practical examples. Four articles. 1 plate. 12000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 12, 19, 26, Dec. 3, 1897. No. 17339 H.

Electric Signaling.

The Applications of Electricity to Railway Signaling. J. Warren. Treats of some of the applications for this purpose, giving illustrations. 1200 w. Elec, Lond—Dec. 3, 1897. No. 17127 A.

Germany.

Electro-Pneumatic Signaling: Bavarian State Railways. An account of the installation of the Westinghouse electro-pneumatic system of signaling. 800 w. Engng—Nov. 26, 1897. No. 17013 A.

Interlocking.

Interlocking Plant at Hammond, Ind. Illustrated description of one of the largest interlocking plants in the United States. 700 w. R R Gaz—Dec. 17, 1897. No. 17174.

Semaphore Signal.

The Union Electric Semaphore Signal. Illustrated description of a signal operated by an electric motor placed in a box at the base of the post. 2000 w. R R Gaz—Dec. 3, 1897. No. 16971.

TERMINALS AND YARDS.

New York Terminals.

The Railroad Terminals of New York. James F. Hobart. Part first gives interesting illustrated accounts of the stations of the Pennsylvania and the Grand Central, with brief reference to the changes that have been made and those in process. 1800 w. Ry Mag—Nov., 1897. Serial. 1st part. No. 17135 C.

Station.

The New Terminal Station of the Orleans Railway at Paris. (La Nouvelle Gare Terminus de la Compagnie d'Orleans, à Paris.) Plans and elevations of the competitive designs submitted for the proposed new railway station on the Quai d'Orsay, in Paris. 3000 w. Le Génie Civil—Dec. 11, 1897. No. 17307 D.

TRANSPORTATION.

Accident.

Report of the New York State Railroad Commission on the Garrisons Disaster. Abstract from the report giving valuable information regarding the construction of the track and roadbed at the point where the accident occurred. 3500 w. Eng News—Dec. 23, 1897. No. 17253.

The Garrisons Accident. Report of the investigation by the State Railroad Commission, as given in the *Albany Argus*. Illustrations of plan and sections presented. 1300 w. R R Gaz—Dec. 10, 1897. No. 17092.

The Garrisons Wreck. Summary of the report on the accident, by the New York State Board of Railroad Commissioners. 5000 w. Ry Age—Dec. 24, 1897. No. 17439.

Train Accidents in the United States in October. Detailed list with classified summary. 4500 w. R R Gaz—Dec. 3, 1897. No. 16968.

Earnings.

Heavy Railroad Earnings Continue. Report of the returns for November, which surpass all previous records in some particulars, giving tabulated statements of increases and decreases and other details. 1400 w. Bradstreet's—Dec. 11, 1897. No. 17104.

Freight.

The Movement of Freight on the German Railways in 1896. (Die Güterbewegung auf Deutschen Eisenbahnen im Jahre 1896.) Giving comparative tables with 1895, 94 and 93, especially as regards metals and ores. 1200 w. Glückauf—Nov. 27, 1897. No. 17370 B.

Pooling.

The Legalization of Pooling. Editorial giving views of prominent railroad men, with comments. 900 w. R R Gaz—Dec. 10, 1897. No. 17093.

The Railroads and a Pooling Bill. Discusses the present situation and the grounds of the railroad opposition to the bill. 800 w. Bradstreet's—Dec. 18, 1897. No. 17195.

MISCELLANY.

Anti-Trust Law.

Railway Associations. Aldace F. Walker. Explains what these associations are, and the work undertaken by them, showing the absurdity of attempting to subject them to the Anti-Trust statutes. 8000 w. Ry Mag—Nov., 1897. No. 17134 C.

Blacksmithing.

Kinks in Blacksmithing on the Louisville & Nashville Railroad. Description, with illustrations, of special methods in use. 2500 w. Loc Engng—Dec., 1897. No. 16939 C.

Inspection.

The Annual Inspection of the Boston & Albany Railroad. George W. Blodgett. Account of the inspection annually made on this road, with illustrated description of the principal features of the Dudley dynagraph car. 2000 w. R R Gaz—Dec. 17, 1897. No. 17175.

Irish Railway.

A Novel Irish Railway. Alfred Slater. Presidential address before the Gloucestershire Engineering Society. Describes a novel light railway built on the Lartigne system. A single-rail line. 1800 w. Arch, Lond—Dec. 17, 1897. No. 17452 A.

Light Railways.

Light Railways. J. B. Corrie. Describes

and illustrates a car, invented by E. R. Calthrop, for transporting standard railway waggons over narrow gauge lines. 2000 w. Ind & Ir—Nov. 26, 1897. No. 17027 A.

New Zealand.

Railway Results in New Zealand. Facts from report of Mr. Cadman, Minister of Railways, showing the results of the past year to be very satisfactory. 1200 w. Transport—Dec. 10, 1897. No. 16906 A.

Ownership.

State versus Private Railroad Ownership. Leonard Darbyshire. Discussion of the arguments advanced in favor of state ownership. 3400 w. Ry Mag—Nov., 1897. No. 17136 C.

Queensland.

The Railways of Queensland. Report of the past year showing increase in earnings and improvements under discussion. 1300 w. Trans Nov. 19, 1897. No. 16935 A.

Railways.

Railways and the Public. John W. Noble. Address at Purdue University. A discussion of some of the mutual obligations of railroad corporations and the people. Some of the statements made have been challenged by H. P. Robinson of Chicago. 7500 w. Ry Age—Dec. 10, 1897. No. 17098.

Railway Schemes.

Railway Schemes in Parliament. Editorial comment on projects in England for the improvement and extension of the railways. 2500 w. Engng—Nov. 26, 1897. Serial. 1st part. No. 17012 A.

Safety.

Safety and Economy in Railway Operations. (Betriebssicherheit und Oekonomie in Eisenbahnwesen.) A paper before the German Railway Society by Herr Haarmann discussing German, English and American statistics, from 1881 to 1895, showing the close relation between safety and economy, in the operation of railways. 10000 w. Glaser's Annalen—Dec. 1, 1897. No. 17354 D.

South Wales.

The South Wales Railway Struggle. A statement of the projects for extending the railways. 900 w. Engr, Lond—Dec. 3, 1897. No. 17125 A.

STREET AND ELECTRIC TRAMWAYS.

Accumulators.

The Use of Accumulators in Central Stations of Electric Tramways. Ludwig Schroeder. Abstracted from a communication to the *Elektrotechnischer Verein*. Describes their use on Zurich-Hirslanden line, the Brockenzell-Lettnang line and the Remscheid line. 1500 w. Elec Rev, Lond—Nov. 26, 1897. No. 17015 A.

Basle.

The Extension of the Tramway System of Basle. (Die Erweiterung des Netzes der Basler Strassenbahnen.) With details of this overhead trolley system, including power house, wiring, cars, and motors. Four articles. 7500 w. 1 plate. Schweizerische Bauzeitung—Oct. 30, Nov. 6, 13, 20, 1897. No. 17364 H.

Central Stations.

See Electrical Engineering, Power.

Conductors.

Discussion of the Existing Systems of Conductors for Electric Tramways. (Betrachtungen der Ueblichen Stromzuführungs systeme.) A critical comparison between overhead, underground and accumulator systems. 6000 w. Deutsche Zeitschr f Elektrotechnik—Nov. 15, 1897. No. 17387 B.

Conduit Construction.

Conduit Railway Construction of the Metropolitan Street Railway Company, of New York. Illustrated account of this extensive work, with reasons for selecting this system. 4800 w. St Ry Jour—Dec., 1897. No. 16978 D.

Double-Deck Car.

The Latest Double-Deck Street Car. Illustrated description of a steel-built car, convertible into an open or closed car, having a central vestibule and double entrance. 600 w. Ry Rev—Nov. 27, 1897. No. 16936.

Electric Locomotive.

Four-Wheel Electric Locomotive for Main Line Service. (Zweiachsige Elektrische Lokomotive für Vollbahnen.) Illustrated description of 20-ton electric locomotive for overhead trolley, designed by the *Allgemeine Elektricitäts Gesellschaft* of Berlin. 2000 w. 1 plate. Glaser's Annalen—Nov. 15, 1897. No. 17352 D.

Electric Traction.

Gerry on Electric Traction. Discussion of paper by M. H. Gerry, Jr., on "Electric Traction, Notes on the Application of Electric Motive Power to Railway Service, with illustrations from the Practice of the Metropolitan Elevated Road of Chicago." 3800 w. Trans Am Inst of Elec Engs—Oct., 1897. No 17078 D.

Electrolysis.

Two Cases of Electrolysis. Very full illustrated account of damage to water-pipes in Salt Lake City and in Chicago. 2500 w. St Ry Rev—Dec. 15, 1897. No. 17203 C.

Elevated Roads.

A New Suspended Electric Railway. (Un Nouveau Chemin de Fer Electrique Suspendu.) Description of the Romanow suspended road for the rapid transmission of small parcels, now on exhibition at St. Petersburg. 800 w. Moniteur Industriel—Oct. 16, 1897. No. 16494 F.

Increased Traffic on South Side Elevated, Chicago. Reports a most satisfactory increase in the number of passengers carried since the road began using the new Union Loop. 500 w. R R Gaz—Nov. 5, 1897. No. 16371.

Single Track Elevated Railroads. (Einschienige Hochbahnsysteme.) With illustrations of a number of actual installations of roads in which the cars are suspended from a single rail. Serial. 1st part. 1500 w. Schweizerische Bauzeitung—Dec. 11, 1897. No. 17369 B.

Galicia.

The Lemberg Electric Tramways. Brief illustrated description. 600 w. Ry Wld—Dec., 1897. No. 17210 A.

Germany.

Electric Traction in Germany. J. L. Hernessen. Historical review since the first introduction in 1879. 2000 w. Elec, Lond—Nov. 26, 1897. No. 16999 A.

Glasgow Subway.

Glasgow District Subway. An examination of the financial results as given in the report of the first half year of the working of this railway. Makes comparison with the Liverpool Electric Railway and the South London Electric Railway. 2500 w. Ry Wld—Dec., 1897. No. 17212 A.

Lightning.

Protection from Lightning. Discusses the means taken to preserve the armatures of generators and motors from damage by electric storms, giving the experience in various cities. Ill. 2000 w. St Ry Rev—Dec. 15, 1897. No. 17199 C.

Power House.

A New Power House for Boston, Mass. Illustrated description of the new Harvard station, which represents the West End Ry. company's idea of the most economical railway generating station. Explains building and machinery. 1400 w. Eng Rec—Dec. 18, 1897. No. 17188.

Practical Operation and Maintenance of Electrical Equipment in the Power House. J. D. de Gurchy. Some of the troubles that have occurred in the writer's experience are discussed showing how serious losses may be averted, Ill. 1400 w. St Ry Rev—Dec. 15, 1897. Serial. 1st part. No. 17198 C.

The Largest Steam Plant in the World. Brief illustrated description of the proposed power station of the Metropolitan Street Railway Co. of New York. 1100 w. Power—Dec., 1897. No. 17200.

Rapid Transit.

Financial Characteristics and Operating Organization of the Brooklyn Rapid Transit System. Gives an idea of the organization and administration involved in the management of this property and some of the results achieved. 2000 w. St Ry Jour—Dec., 1897. No. 16979 D.

The Rapid Transit Situation In New York City. Editorial discussion of the decision of the Appellate Division of the Supreme Court, New York, which renders it very doubtful whether the enterprise can ever be carried out. 1200 w. Eng News—Dec. 23, 1897. No. 17258.

Shifting Engine.

Electric Shifting Locomotive. (Elektrische Rangier-Lokomotive.) Illustrating and describing an overhead trolley locomotive arranged to shift from one track and wire to another, for use in yard service. 2000 w. Schweizerische Bauzeitung—Dec. 4, 1897. No. 17368 B.

Stations.

See Electrical Engineering, Power.

Street Railway Lease.

A Hubbub in Boston. Analysis of the lease of the West End street railway of Boston, to the Boston elevated. 2500 w. Elec, N. Y.—Dec. 1, 1897. No. 16944.

Traction.

Electric Traction. Cloyd Marshall. Read before the Chicago Electrical Assn. Reviews the indications of growing importance and the promising outlook for the application of electricity to heavy traction. 2500 w. Elec Wld—Dec. 25, 1897. No. 17251.

The Possibilities and Limitations of Electric Traction. Frank J. Sprague. Advocates the multiple unit system as opposed to the electric locomotive and train system, and predicts the entire displacement of the steam locomotive. 3000 w. Engineering Magazine—Jan., 1898. No. 17392 B.

Travelling Platform.

Travelling Platform with Two Speeds. (Plateforme Electrique à Deux Vitesses.) Report upon the scheme of MM. Blot, Guyenet and Mocomble for a continuous traveling platform as a means of transportation at the Paris Exposition of 1900. The motive power to be electricity and the platform to be elevated. 7500 w. Bulletin de la Société d'Encour—Nov., 1897. No. 17347 F+G.

Vienna.

The Vienna City Railway. (Die Wiener Stadtbahn.) A general account of the new elevated and depressed local railway in Vienna, with map and illustrations. Serial. 1st part. 7500 w. Glaser's Annalen—Dec. 1, 1897. No. 17355 D.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Clayton & Shuttleworth, 95 Queen Victoria St., London, E. C.=Illustrated catalogues. (*a*) Fixed and portable oil engines, giving specifications, approximate weights and dimensions, and instructions for ordering; (*b*) gas engines convertible into oil engines, giving description, prices, dimensions, and weights; (*c*) agricultural locomotives, engines, and wagons; (*d*) Hetts patent centrifugal pumps, with prices, weights and measurements, and interesting technical data; (*e*) general catalogue of boilers, portable and stationary steam engines, and agricultural machinery.

The Hazelton Boiler Co., New York.=Well-printed, well-illustrated, and well arranged and indexed catalogue of 150 pages, in handsome illuminated paper cover, being the sixth edition of the work, necessitated by improvements made in the boiler since the fifth edition was issued. Excellent half-tone illustrations show the works and the Hazelton boiler in course of construction and completed, as well as complete plants fully equipped with Hazelton boilers. The text, however, is broad in its scope, constituting a general discussion of steam-production, accompanied by useful tables and short articles from the writings of Prof. Thurston, William Kent, and C. W. MacCord.

Lambert Hoisting-Engine Co., Newark, N. J., U. S. A.=Large finely-illustrated catalogue of hoisting-, lowering- and swinging-engines of all sizes, and adapted to all classes of work and all modes of power application; also of traveling derricks, hoisters, horizontal engines and tubular boilers. The descriptive text is clearly worded and accompanied by full data of dimensions, power, and weight.

The Crosby Steam Gage and Valve Co., 75 Queen Victoria St, London, E. C.=General catalogue of gages, valves, and general engine and boiler fittings; prices are in most cases added, with list of users.

The Detroit Lubricator Co., Detroit, Mich., U. S. A.=Catalogue of sight-feed and other lubricators. (*a*) Standard edition, giving full particulars of their various types of lubricators; (*b*) railway edition, giving similar information with special reference to locomotive work; it also gives particulars of the "Garfield" injector. Both are well printed.

Luke & Spencer, Ltd., Broadheath, near Manchester.=Catalogue of grinding and polishing machinery and of their patent "consolidated" emery wheels; 109 types of tools are given with full specifications, and in some cases prices.

Ruston, Proctor & Co., Ltd., Lincoln, England.=Handsome illustrated catalogue of 177 pages, devoted to the various types of stationary and portable engines, centrifugal pumps, boilers, and agricultural and general machinery, made by this firm. Half-tone illustrations show the interior of their works in Lincoln.

The Graves Elevator Co., Rochester, N. Y., U. S. A.=Special illustrated catalogue of hydraulic, electric, steel-screw belt, and spur-gear elevators for passengers and freight, and of elevator cars, engines, and safety devices.

Hilles & Jones Co., Wilmington, Del., U. S. A. =Finely-illustrated catalogue of machine tools for boiler makers, bridge builders, car and locomotive builders, iron-ship builders, and workers in plates, bars, and structural shapes generally. The catalogue consists of a series of handsome plates with descriptive titles.

Henry Maurer & Son, New York.=Catalogue of fire-proof building materials of every description and for all purposes, illustrated with excellent perspective cuts, printed in two colors, of hollow tiles, partition and furring blocks, flue linings, and porous terra-cotta and of fire brick and clay retorts. Half-tones show buildings in which the firm's products were employed.

Schäffer & Budenberg, Whitworth St, London Road, Manchester, England.=Catalogue of convenient size, fully illustrated, of pressure gages, valves, steam engine governors, sluice valves, and a variety of boiler and engine fittings. Tables of weights and measures, properties of steam, and areas of arches; in general the information is very condensed.

J. H. Holmes & Co., Portland Road Works, Newcastle-on-Tyne, England.=(*a*) Catalogue of the "Lundell" continuous-current electric motors, with illustrations, sizes, and prices; (*b*) 40-page detailed list of some of the firms and steam ships supplied with "Castle" dynamos; (*c*) catalogue of the "Castle" dynamos and motors, showing these generators for belt driving, rope driving, dynamos with flywheels and direct connected on the Willans-Holmes system; prices and dimensions and instructions for telegraphic ordering are given; (*d*) loose sheets showing illustrated applications of the Lundell motors for printing-machinery and other purposes.

Robey & Co., Ltd., Globe Works, Lincoln, England.=Well arranged illustrated catalogue of steam engines, and boilers for marine and land service, with specifications for their types of feed pumps. Dimensions are all given both in the English and metric systems.

Bolling & Lowe, 2, Laurence Pountney Hill, London, E. C.=Trade review for the year 1897, embracing in its scope both home and foreign trade. The subjects especially referred to are: the engineering strike in Great Britain; railway, canal, and water-way traffic; government ownership of railways; steel rails; steel for shipbuilding; tin plates; municipal improvements; extensions of ports and dry-dock yards; currency question. A very business-like review, which the firm offers to send to any part of the world, free of charge.

For Additional Catalogues see page 36.

IMPROVED MACHINERY

NEW PROCESSES — NEW APPLIANCES

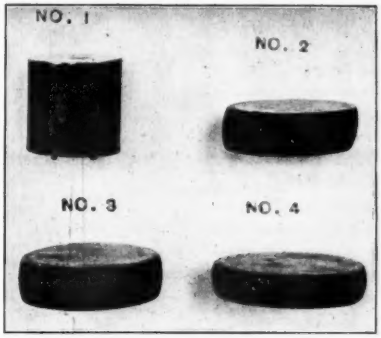
The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

An Improvement in Drop-Hammer Practice.

THE largest drop hammer in the world, probably, has recently been installed by the Billings & Spencer Co., of Hartford, Conn., U. S. A., to meet the necessity arising in their work for a hammer displacing a large amount of metal at a single blow.

Displacement of large masses by few heavy blows, instead of many light ones, was desirable both for convenience and economy.

THE LARGEST DROP HAMMER IN THE WORLD.



COMPRESSION OF A COPPER CYLINDER.

1. Original Cylinder, 1"x1".
2. Result of 100,000 lbs.' pressure.
3. Effect of 1100-lb. hammer on 9,000 lb. base.
4. Effect of 1100-lb. hammer on 18,000 lb. base.

Both in size and mode of operation, therefore, the hammer marks a new departure; and, beyond this, it introduces a novelty in practice in the construction of the foundation, which is designed to secure absolute rigidity and immovability, rather than the elasticity which has generally been considered essential.

The following dimensions are given:

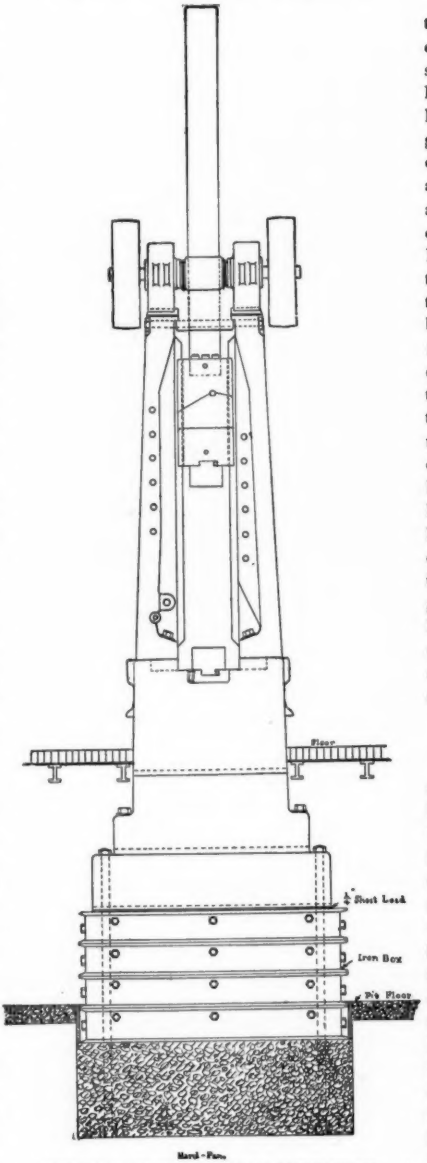
Weight of hammer	3,000 lbs.
Weight of base	60,000 lbs.
Total weight of base	90,000 lbs.
Size of base at bottom	45X90 inches
Length of uprights	11 feet 3 inches
Between ways on uprights	18 inches
Height from floor to top of pulleys	16 feet 9 inches
Total height required above floor to operate machine	23 feet
Extreme fall	6 feet 4 inches
Shortest automatic fall	31 inches
Bottom of casting to top of pulley	21 feet 9 inches

An automatic shifting of the lifting rolls makes possible a gradual release of the rolls from the lifting board at any point of the upward move-

ment, or a gradual engagement of the rolls with the lifting board at any point of the descent.

The effective stroke of the hammer can also be regulated to suit the requirements of different kinds of work.

The foundation, however, constitutes not the least interesting feature of the work. The tool will ultimately be placed in the hammer-shop of the Billings & Spencer works, and here an excavation was carried down to hard pan. Over this was laid three feet of concrete, (3 sand, 1 cement, 1 broken stone,) in a form nine by five feet. Above this was built up a box four feet by eight feet (nearly) and forty-five inches deep, made of 15-inch channels, laid on the yet unset concrete below and filled with concrete. On the upper surface of this concrete base was placed a ¼-inch lead sheet, and on this were set three 20,000-lb. cast-iron base sections, keyed together by a groove-and-tongue arrangement, and all bolted solidly to the concrete below.



VERTICAL SECTION THOUGH FOUNDATION.

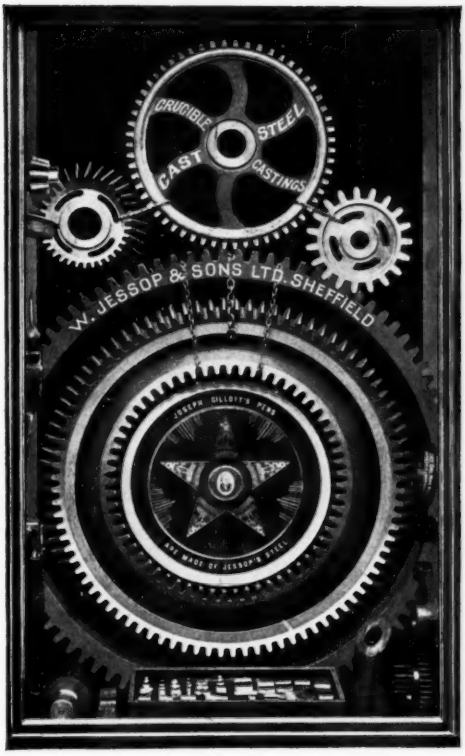
Justification for Messrs. Billings & Spencer's belief in the efficiency of a heavy base is afforded by the specimens photographed and shown in the accompanying illustration. In the upper left hand corner is a 1″×1″ copper cylinder. To the right is shown the effect on such a piece of the application of a pressure of 100,000 lbs. Just below the original cut is shown the effect of an 1100-lb. hammer on a 9000-lb. base, while to the right of that is shown the effect, on a precisely similar specimen, of an 1100-lb. hammer on an 18,000 lb. base. The photographs, being all on exactly the same scale, afford at once to the eye an exact representation of comparative effects. It will be observed that the least deformation of the specimen was caused by the pressure of 100,000 lbs. Next in effect was the blow of the 1100 lb. hammer on the 9,000 lb. base. The most striking change of all is that produced by the same weight hammer on the heavier base. The greatly increased effect secured in this last instance suggests that the installation just described constitutes a marked advance in drop-hammer practice.

Jessop's Steel.

In the old-fashioned and prosaic portion of lower John street, New York, devoted chiefly to the metal trade, a spirit of enterprise on the part of William Jessop & Sons has introduced an innovation which causes the occupants of adjacent places to pause in contemplation. For over half a century the premises at the corner of Gold street have made little claim on the attention of the casual passer, although the quality and reputation of the firm's product has always made it of interest to manufacturers of first-class tools. Recently a plate-glass show window has been put in the John-street front, wherein a tasteful arrangement of crucible-steel castings, cast car and gear wheels,

cutter blanks, tool steel and other products of the Jessop works are on exhibition. Occupying the space within the central gear wheel, in striking contrast to this ponderous mass of material, is a handsome show-case containing a collection of steel pens of the celebrated Gillott brand, made of Jessop's steel, and arranged in star form, showing the various styles of this delicate instrument for which steel is used.

The whole arrangement is well worth the inspection of those interested in metals, and it is one of the brightest displays in John street.



A DISPLAY OF JESSOP'S STEEL.

A Handy Pocket Level.

THE engraving represents a useful little instrument recently put on the market It consists of an accurately-turned base and cap, holding an accurately-ground lens in position; the hollow of the case or base is filled with alcohol, leaving a small air bubble in it.

"WHICH-WAY" LEVEL.

The center of the base has a small tit, which is used to indicate when the bubble is exactly in the middle, and the work level. Placed on any object which it is desired to test, it will tell in an instant just which way the work is out. The utility of this little instrument can readily be seen without further explanation. It is nickel plated and the size of a dollar. The maker, E. G. Smith, Columbia, Pa., calls it very appropriately "Which Way," and would be pleased to send circulars to any one interested.

A Remarkable Record.

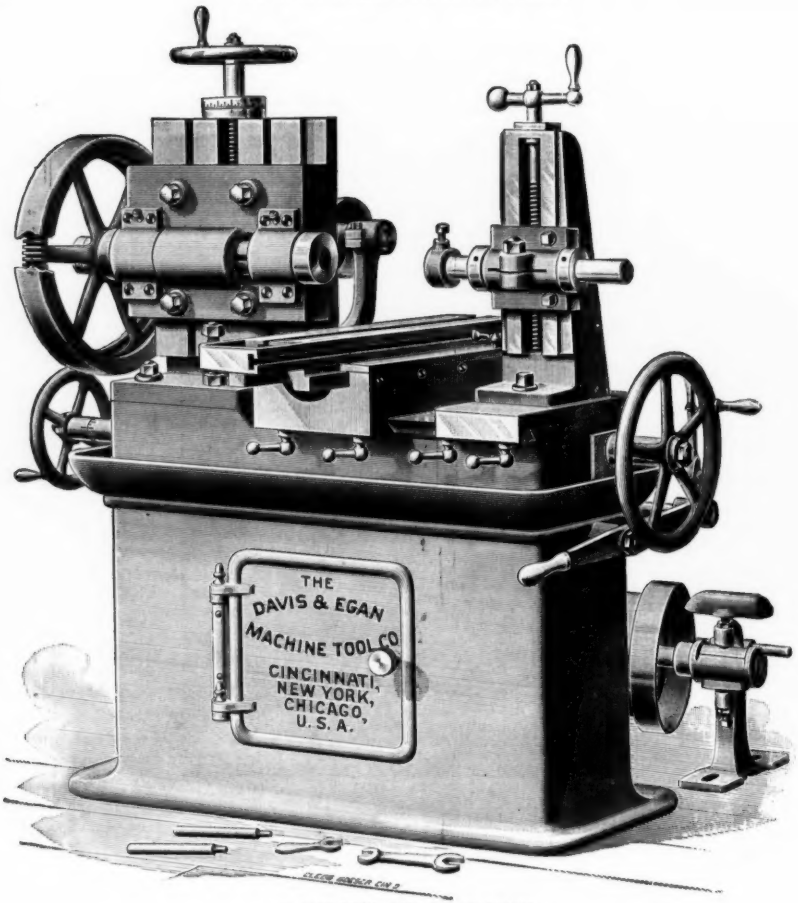
A REMARKABLE record in hoisting and conveying material by means of the Lidgerwood Traveling Cableway is shown in the work done by this apparatus on Section "D" of the Chicago Drainage Canal. In the "Proceedings of the Board of Trustees of the Sanitary District of Chicago," published recently, occurs the following report: "The cableway continued work during the month, removing 12,519 cubic yards in 20½ shifts, an average of 611 cubic yards per shift."

A shift on the drainage canal means 10 hours work. Inasmuch as the Lidgerwood Manufacturing Company have claimed all along that their cableway was capable of handling 500 cubic yards per day, if it were fed to the machine, this record is interesting, showing as it does an average for a month of 611 yards per day, or 111 cubic yards per day more than claimed by the builders.

Improved Milling Machine.

THE cut on the next page illustrates an excellent machine tool made by The Davis & Egan Machine Tool Co., of Cincinnati, and by them styled the "Improved No. 1 Lincoln Milling Machine."

The bed is 13¾ inches wide, 6½ inches deep,



AN IMPROVED MILLING MACHINE.

and is cast with the pan, which serves as a receptacle for oil, chips, etc. It rests on a cabinet the full width of the machine, making a very rigid construction. The cabinet is fitted with a cupboard for holding tools, wrenches, etc. The spindle is made of crucible steel and has a ¾-inch hole through its entire length. It is mounted on a rectangular slide and runs in boxes lined with genuine babbitt metal. The main head is gibbed on both sides to a rigid upright. It has 7½-inch vertical adjustment and is securely clamped by four bolts. It is raised and lowered by a single screw, which is provided with an index reading in thousandths. Its position is determined by a stop screw, so that the cutter can be raised and brought back to the same place. The spindle gear is 16¼ inches in diameter, 2-inch face, and is driven by a 4-inch pinion on the cone shaft. The relative position of spindle and cone shaft is maintained by a link connecting the two. The cone has three steps, 10½ inches, 8¼ inches and 6 inches, for a 3 inch belt. The table is 32¾ inches long, 6½ inches wide, has 18-inch automatic feed, and large pockets in each end. The countershaft has pulleys 12 inches in diameter for 3¾-inch belt and should run 125 revolutions per minute.

The machine is heavy, compact, and substantial throughout, and has just been placed in the market by The Davis & Egan Co., who will gladly furuish further particulars on application.

A New Armstrong Pipe Cutter.

THE engraving shows an improved form of the well-known No. 3 pipe cutter manufactured by

the Armstrong Manufacturing Company. This tool, it is claimed, is the strongest and most rapid-working pipe cutter on the market, and the cheapest, because it takes a larger range of pipe than any other tool made for a like purpose, viz., from 1½ inches to 4 inches, inclusive.

ARMSTRONG PIPE CUTTER.

The change from the smallest to the largest size is made by simply raising a pawl and allowing the hooked bar to slide outward. To change to a smaller size, the hooked bar is pushed in to the required size, when it is ready to cut. The thread on the handle is only used to follow up the cut as the cutter is revolved about the pipe. This cutter may be changed from a three-wheel to a one-wheel cutter, by simply substituting rollers in place of the two cutter-wheels at the end of the hooked bar.

Full information will be furnished our readers upon application either to the home office of The Armstrong Mfg. Co., at Bridgeport, Conn., or 139 Centre street, New York city.

To Preserve Air-Brake Hose.

THE best of air brake hose is too short lived. Its weakest part seems to be at a point directly opposite the open end of the twin hose nipple. Here abrasions and leaks most frequently manifest themselves, for the reason that a harsh iron edge is constantly rubbing against, and forcing itself into, a rubber surface that stretches with every bend, bringing the shock directly upon the frictioned canvas. Thus it often occurs that the inner hosetube, the "friction," and the core all suffer equally under this persistent chafing, and early develop leaks. The illustration shows a very simple and effective remedy, the invention, by the way, of one who was formerly a railroad man and who to-day is a very large manufacturer of railway equipment in rubber. Explained in brief: — a moulded rubber cap, of sufficient thickness to form a cushion, is fitted over the projecting end of the iron nipple, and,—that is all. Yet it not only presents a yielding surface to the swinging and bended hose, but it does away entirely with the sharp break on the rigid iron edge. Actual tests show that the use of this cap increases the life of air-brake hose from 45 to 55 per cent. This device, which is called the "Peerless" Hose-Nipple Cap, is manufactured by the Peerless Rubber Mfg. Co., 16 Warren street, N. Y., owners of the American and European patents.

PEERLESS HOSE-NIPPLE CAP.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine when you write.

The Jeffrey Mfg. Co., Columbus, Ohio, U. S. A.=Originally-designed illustrated catalogue of Jeffrey-Robinson coal-washing machinery. A number of detached leaves, held in an attractive cover, illustrate a typical plant erected for experimental purposes. Data and description are given.

John Moncrieff, North British Glass Works, Perth, Scotland.=(*a*) Latest price list of gage glasses; (*b*) illustrated sheets of needle and brass-mounted lubricators; (*c*) hints on packing steam boiler water gage glasses.

W. S. Laycock, Victoria Street Works, Sheffield, England.=A series of plates in a folder, giving particulars of railway and steamship specialties. These include a patent elastic journal packing, and heaters, arm rests, draught excluder, window lift, and spring seat and back for railway carriages. Each plate is separate and is accompanied by a brief description.

The Brush Electrical Engineering Co., 49 Queen Victoria St, London, E. C.=Well-printed and illustrated cloth-covered catalogue and price list of Brush dynamos, transformers, switch fuses, and electrical accessories. Weights and dimensions are given both in the English and metric systems.

A. A. Griffing Iron Co., New York.=Illustrated catalogue of "Bundy" steam-traps, with descriptive text and testimonials.

The J. M. Carpenter Tap and Die Co., Pawtucket, R. I., U. S. A.=Handy illustrated catalogue of screw-cutting tools, including taps, dies, screw plates, die stocks, tap wrenches, etc.

The Dunn Mfg. Co., Pittsburg, Pa., U. S. A. =Small illustrated catalogue of patent extensible trench-braces, for supporting the sides of excavations. The views of actual applications of the device are well chosen and effective.

E. G. Smith, Columbia, Pa., U. S. A.=(*a*) Catalogue and price list of calipers for many special classes of work, and of micrometers, spherometers, and triangles; (*b*) leaflet of the "Which Way" level, for instantly determining which way work is out of level.

H. W. Johns Mfg. Co., New York.=Descriptive catalogue of vulcabeston, a special material for insulation and packing.

Bullivant and Co., Millwall, London, E.=(*a*) Catalogue of wire mining- and hauling-ropes, by J. Bucknall Smith, giving information on the technology, manufacture, and applications of wire ropes; (*b*) general catalogue, with illustrations of wire-rope fittings, aerial tramways, mining and hauling plants, power-transmission and other plants installed by this company; (*c*) pamphlet entitled "Going to the Isle of Dogs, by Lesser Columbus," being a popular and rather humorous account of Messrs. Bullivant's works.

The Cycle Components Mfg. Co., Ltd., Bournbrook, Birmingham, England.=An excellently printed and illustrated list, in board covers, of frames, fittings, and cycle accessories.

Davey Paxman & Co., Colchester, England.= 116-page illustrated catalogue containing illustrations, dimensions, and weights of portable, horizontal fixed, and vertical engines; of winding, hauling, and air-compressing machinery, and of steam boilers, pumps, and general mining machinery. An index is provided, and a chapter at the end gives areas of circles, foreign weights and measures, etc. The catalogue is well printed on excellent paper.

The Chas. B. King Co., Detroit, Mich., U. S. A.=Illustrated catalogue of gasoline engines for marine applications. The descriptive text is concise and well arranged.

Fielding & Platt, Ltd., Gloucester, England.= Catalogue of Tweddell's system of hydraulic machine tools, including all types of hydraulic tools in general use, with a list of users, and instructions for ordering attached to each machine. The catalogue is bound in cloth, well indexed, and extends to 138 pages.

J. S. & G. F. Simpson, Brooklyn, E. D., N. Y., U. S. A.=Illustrated catalogue of Bogardus eccentric mills, adapted for grinding every kind of material, hard, soft or wet.

Norton Emery-Wheel Co., Worcester, Mass., U. S. A.=Neat catalogue of the Walker universal tool- and cutter-grinder, showing its original and special features and its adaptation to a wide range of work. The illustrations in white line on black background are very effective, and show the application of the machine to special service.